ROCKFORD INSTRUMENT LAB
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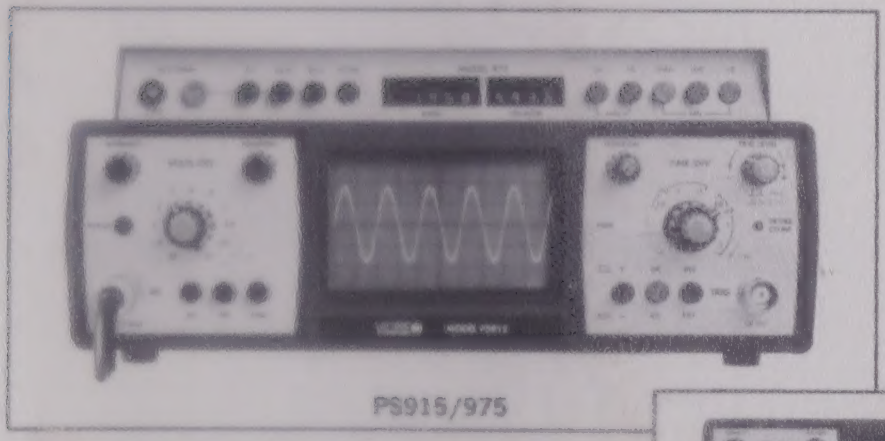
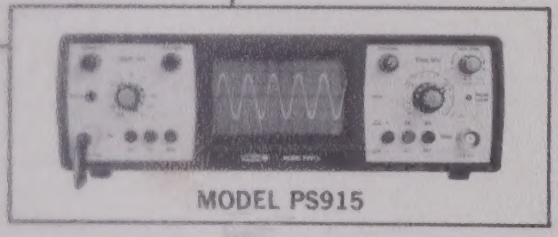
TECHNICAL MANUAL

MODEL PS915/975

DMM—COUNTER—MINI-SCOPE



PS915/975



MODEL PS915

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TABLE OF CONTENTS

Section	Para.	Title	Page
I		GENERAL DESCRIPTION	1-1
	1-1	INTRODUCTION	1-3
	1-5	INSTRUMENT DEFINITION	1-3
	1-11	APPLICATION	1-4
	1-15	PHYSICAL DESCRIPTION	1-7
	1-22	SPECIFICATIONS - PS915 MINI-SCOPE	1-13
	1-22	SPECIFICATIONS - PS975 DMM/COUNTER	1-15
	1-23	ACCESSORIES	1-16
	1-26	ORDERING INFORMATION	1-16
II		INSTALLATION	2-1/2-2
	2-1	INSPECTION UPON RECEIPT	2-3
	2-2	BATTERY OPERATION	2-3
III		OPERATION	3-1/3-2
	3-1	FRONT PANEL CONTROL FUNCTIONS AND CONNECTIONS	3-3
	3-2	VERTICAL SECTION	3-3
	3-3	HORIZONTAL SECTION	3-4
	3-4	DMM/COUNTER SECTION	3-6
	3-5	REAR PANEL CONTROL FUNCTIONS AND CONNECTIONS	3-7
	3-6	FIRST TIME OPERATION	3-7
	3-7	GENERAL OPERATION	3-9
	3-8	INPUT SIGNAL PROBES	3-9
	3-9	VERTICAL DISPLAY	3-9
	3-10	HORIZONTAL DISPLAY	3-9
	3-11	TRIGGERING	3-10
	3-12	CRT CONTROLS	3-10
	3-13	DMM OPERATION	3-10
	3-14	COUNTER OPERATION	3-10
IV		THEORY OF OPERATION	4-1/4-2
	4-1	GENERAL	4-3
	4-3	INPUT COUPLING AND VERTICAL ATTENUATOR (A SECTION)	4-3
	4-4	VERTICAL INPUT BUFFER	4-3
	4-5	VERTICAL ATTENUATOR (B SECTION) AND OUTPUT BUFFER	4-4
	4-6	VIDEO AMPLIFIER AND VERTICAL OUTPUT AMPLIFIER	4-5
	4-7	TRIGGER GENERATOR AND TRIGGER CONDITIONING	4-6
	4-8	COUNTER LEVEL SHIFTING	4-6

TABLE OF CONTENTS (Continued)

Section	Para.	Title	Page
	4-9	SWEEP GENERATION AND CONTROL	4-7
	4-10	SWEEP GENERATOR	4-7
	4-11	HOLD-OFF MONOSTABLE MULTIVIBRATOR	4-8
	4-12	SWEEP CONTROL CIRCUIT	4-8
	4-13	AUTO TRIGGER OSCILLATOR	4-9
	4-14	BLANKING GENERATOR	4-10
	4-15	EXTERNAL X AXIS INPUT (X-Y OPERATION)	4-11
	4-16	X AXIS CONDITIONING LOGIC	4-11
	4-17	X AXIS SIGNAL SCALING	4-12
	4-18	HORIZONTAL OUTPUT AMPLIFIER	4-12
	4-19	POWER SUPPLY	4-13
	4-20	BATTERY CHARGER	4-14
	4-21	PROBE COMPENSATOR	4-14
	4-22	THEORY OF OPERATION - MODEL 975	4-15
	4-23	DMM FUNCTION SELECTION AND CONTROL	4-15
	4-24	"Scope" Button Depressed	4-15
	4-25	"DCV" Button Depressed	4-15
	4-26	"ACV" Button Depressed	4-16
	4-27	"KΩ" Button Depressed	4-16
	4-28	INPUT BUFFER	4-16
	4-29	AC CONVERTER	4-17
	4-30	OVERLOAD LIMITING AND OUTPUT SWITCHING	4-17
	4-31	REFERENCE	4-17
	4-32	OHMS CONVERTOR	4-18
	4-33	RANGE DRIVERS	4-18
	4-34	ANALOG PROCESSOR AND DIGITAL PROCESSOR	4-19
	4-35	BCD-SEVEN-SEGMENT DECODER	4-19
	4-36	READOUT AND DECIMAL POINT LOGIC	4-19
	4-37	AUTO RANGE CONTROL	4-19
	4-38	DOWNRANGE CONDITION	4-19
	4-39	UPRANGE CONDITION	4-20
	4-40	COUNTER OPERATION	4-20
	4-41	RANGE SELECTOR AND INPUT FREQUENCY DIVISION	4-20
	4-42	CRYSTAL OSCILLATOR AND TIMING CIRCUITRY	4-21
	4-43	GATE GENERATION AND HOUSEKEEPING	4-21
	4-44	FOUR-DIGIT COUNTER	4-21
	4-45	BCD-SEVEN-SEGMENT DECODER AND READOUT	4-21
	4-46	OVER-RANGE FLASHER	4-22
V		MAINTENANCE	5-1/5-2
	5-1	GENERAL	5-3
	5-2	PREVENTIVE MAINTENANCE	5-3
	5-3	Cleaning	5-3
	5-4	Inspection	5-4

TABLE OF CONTENTS (Continued)

Section	Para.	Title	Page
	5-5	Tightening	5-4
	5-6	Recalibration	5-4
	5-7	TROUBLESHOOTING	5-4
	5-8	Troubleshooting Precautions	5-5
	5-9	PARTS IDENTIFICATION	5-6
	5-10	Corrective Maintenance	5-6
	5-11	MODEL PS915 CALIBRATION	5-6
	5-12	Test Equipment Required	5-7
	5-13	Location of Controls for Alignment	5-7
	5-14	Preliminary Control Settings	5-7
	5-15	POWER SUPPLY CALIBRATION	5-8
	5-17	VERTICAL CALIBRATION	5-10
	5-18	HORIZONTAL/X CHANNEL AMPLIFIER CALIBRATION	5-12
	5-19	CALIBRATOR ADJUSTMENT	5-15
	5-20	MODEL 975 DMM/COUNTER CALIBRATION PROCEDURE	5-16
	5-21	Test Equipment Required	5-16
	5-22	Location of Controls for Alignment	5-16
	5-23	DMM/Counter Master Clock Calibration	5-16
	5-24	Reference Voltage Calibration	5-18
	5-25	A-D Converter Zero Adjust	5-18
	5-26	DC Voltage Offset Adjust	5-18
	5-27	DC Voltage Calibration	5-18
	5-28	AC Converter Calibration	5-19
	5-29	Ohms Converter Calibration	5-19
VI		PARTS LIST	6-1
		Manufacturers Code	6-2
VII		DRAWINGS	7-1/7-2
VIII		RECOMMENDED SPARES	8-1/8-2
		WARRANTY	

LIST OF ILLUSTRATIONS

Section	Figure	Title	Page
I	1-1	MODEL PS915/975 DMM-COUNTER-MINISCOPE	1-2
	1-2	FRONT PANEL CONTROLS FOR MODEL PS915/975	1-5
	1-3	REAR PANEL CONTROLS FOR MODEL PS915	1-5
	1-4	SUB-ASSEMBLIES COMPRISING MODEL PS915/975	1-8
	1-5	BOTTOM PANEL VIEW OF PS915/975 WITH BATTERY PACK OPTION INSTALLED	1-9/1-10
	1-6	DIMENSIONAL OUTLINE DRAWING	1-11/1-12
III	3-1	LOCATION OF FRONT PANEL OPERATING CONTROLS MODEL PS915/975	3-5
IV	4-1	SIMPLIFIED VERTICAL INPUT BUFFER BLOCK DIAGRAM	4-4
	4-2	BLOCK DIAGRAM PS915	4-23/4-24
	4-3	BLOCK DIAGRAM Model 975	4-25/4-26
V	5-1	LOCATION OF FRONT PANEL OPERATING CONTROLS MODEL PS915/975	5-9
	5-2	LOCATION OF REAR PANEL CONTROLS MODEL PS915	5-11
	5-3	PS915 CALIBRATION ADJUSTMENT LOCATION	5-13
	5-4	MODEL 975 CALIBRATION ADJUSTMENT LOCATION	5-17
	5-5	MASTER BOARD SUB-ASSEMBLY 9155001	5-35/5-36
	5-6	SWEEP AMP SUB-ASSEMBLY 9155003	5-37/5-38
	5-7	DMM/FREQUENCY COUNTER SUB-ASSEMBLY 9755001	5-39/5-40
VII	7-1	MASTER BOARD SCHEMATIC-HORIZONTAL 9151001	7-3/7-4
	7-1	MASTER BOARD SCHEMATIC-VERTICAL 9151001 (Continued)	7-5/7-6
	7-1	MASTER BOARD SCHEMATIC-POWER SUPPLY 9151001 (Continued)	7-7/7-8
	7-2	WIRING DIAGRAM MASTER BOARD 9151015	7-9/7-10
	7-3	DMM/FREQUENCY COUNTER SCHEMATIC 9751001	7-11/7-12
	7-3	DMM/FREQUENCY COUNTER SCHEMATIC 9751001 (Continued).	7-13/7-14

LIST OF TABLES

Section	Table	Title	Page
IV	4-1	RANGE SELECTOR AND INPUT FREQUENCY DIVISION	4-20
V	Misc. Tables	TRUTH TABLES AND BASING DIAGRAMS FOR INTEGRATED CIRCUITS AND TRANSISTORS	5-21
VI	6-1	MODEL PS915 ASSEMBLIES	6-3
	6-2	MODEL 975 ASSEMBLIES	6-3
	6-3	PARTS LIST (FINAL ASSEMBLY 9155008)	6-4
	6-4	PARTS LIST (CHASSIS ASSEMBLY 9155007)	6-6
	6-5	PARTS LIST (REAR PANEL SUB-ASSEMBLY 9155006).	6-8
	6-6	PARTS LIST (FRONT PANEL SUB-ASSEMBLY 9155005)	6-9
	6-7	PARTS LIST (VERTICAL SWITCH SUB-ASSEMBLY 9155004) . . .	6-10
	6-8	PARTS LIST (SWEEP AMP SUB-ASSEMBLY 9155003)	6-11
	6-9	PARTS LIST (MASTER BOARD SUB-ASSEMBLY 9155001).	6-13
	6-10	PARTS LIST (BATTERY PACK OPTION ASSEMBLY 9155016) . . .	6-30
	6-11	PARTS LIST (CHASSIS ASSEMBLY 9755006)	6-31
	6-12	PARTS LIST (DMM/FREQ COUNTER SUB-ASSEMBLY 9755001). . .	6-32

SECTION I

GENERAL DESCRIPTION

Figure 1-1. Model PS915/975 DMM/Counter-Mini-scope

1-1. INTRODUCTION

1-2. This manual contains complete operation, calibration and maintenance instructions for the Model PS915/975 DMM/Counter-Mini-scope. It should be employed for the Model PS915 Mini-scope alone, or in combination with the Model 975 DMM/Counter. See Figure 1-1.

1-3. The purpose of this manual is to provide the operation, calibration and maintenance information required by the equipment operator or service technician. The manual does not include information pertaining to special equipment applications, nor does it include instructions for accomplishing repairs of the type performed at the factory.

1-4. The manual is divided into eight sections. Section I provides general information regarding the purpose of the equipment, its physical arrangement, and its pertinent specifications. Section II contains information on installation and unpacking. Section III contains instructions for operating the equipment. Section IV describes the theory of operation of the equipment, circuits and mechanisms. Section V provides test, alignment, and maintenance procedures. Section VI contains a complete parts list. Section VII contains complete circuit drawings. Section VIII provides a list of recommended spare parts.

WARNING

When performing the power supply alignment, the instrument may be operating with the covers removed. High voltages, which could be lethal, are accessible and extreme caution should be taken. Only screwdrivers with insulated shafts should be used for setting the adjustments. The covers should be removed only for the duration of time to make the alignments. The power should be off while the covers are being removed or installed.

1-5. INSTRUMENT DEFINITION

1-6. The Model PS915 is classified as a "mini-scope", in that it is less than 10 pounds in weight, is small enough to fit into a tool kit or brief case, and offers battery power capability. As such, it serves as a useful high frequency visual trouble-shooting tool for field service and laboratory test applications. In conjunction with the Model 975 DMM/Counter, the versatility of this test instrument is greatly inhanced.

1-7. In summary, the Vu-data Model PS915/975 DMM/Counter-Mini-scope is the world's first test instrument that includes a digital multimeter (DMM), a frequency counter and an oscilloscope packaged together in a single unit with all three measuring devices possessing their own dedicated displays. All three "sub-instruments" can be employed simultaneously as complements to each other, or they may be used independently at the same time.

1-8. The Model PS915 Mini-scope is a 20 MHz bandwidth, triggered sweep, single trace oscilloscope. Vertical sensitivity is 10 mV/div, and fastest sweep rate is 100 nsec/div which can be increased to 20 nsec/div by a X5 magnifier. External trigger as well as external X-axis input capability are also included. The CRT viewing area is 6 x 10 major divisions, with each division equal to 1/4 inch. Model PS915 may be ordered separately, or in combination with the Model 975 DMM/Counter. Model 975 includes a 3 1/2 digit, auto-ranging digital multimeter (AC volts, DC volts, and Ohms), as well as a 4 digit, 20 MHz frequency counter. The unit can be operated from normal AC power line, from an external 12V DC source, or from an optional battery pack which secures to the bottom panel. Basic dimensions for the Model PS915 are 2 1/2"H x 8 1/2"W x 12 1/2"D. With the 975 added, total package height is increased to 3 1/2". Combined wight is 10 pounds.

1-9. Aside from the front panel controls for the features mentioned above, the rear panel includes the following controls: switch for power on/off or battery charging; AC power line fuse holder with combination power connector and AC line voltage selector mechanism (100V, 120V, 220V or 240V); CRT astigmatism and trace angle adjustment. The optional battery pack is mounted to the bottom panel; in its absence, jacks are available on the bottom panel for external battery or DC power. The Model 975 DMM/Counter mounts to the top of the unit and is powered from the Model PS915 Mini-scope. See Figures 1-2 and 1-3.

1-10. Standard accessories which accompany each unit at time of shipment include a technical manual, detachable AC power line cord, front panel protective hood, 3 ft. alligator clip probe [omitted if optional 10:1/1:1 (switchable) probe kit included] and DMM test leads when Model 975 DMM/Counter is included. See paragraph 1-27 for a complete listing of optional accessories.

1-11. APPLICATION

1-12. The reality of today's needs in a mobile test equipment environment has been faced up to, and Vu-data has acknowledged this by recognizing the need for coordinated measurements. This has been accomplished in the Model PS915/975 by supplying a DMM, counter and scope in a single package in which all three instruments can be used to complement each other simultaneously using a single input, or each can be employed independently from the other two.

Furthermore, the Model 975 DMM/Counter provides the ultimate solution to an age-old oscilloscope nuisance. In the past, the RMS value of a sine wave presentation on a scope was determined by a tedious mental calculation. First, the vertical deflection on the CRT was carefully measured in major and minor graticule divisions, after making sure the vertical attenuator vernier was in "CAL". The attenuator setting was observed next and multiplied by the number of divisions previously measured. This product, peak-to-peak

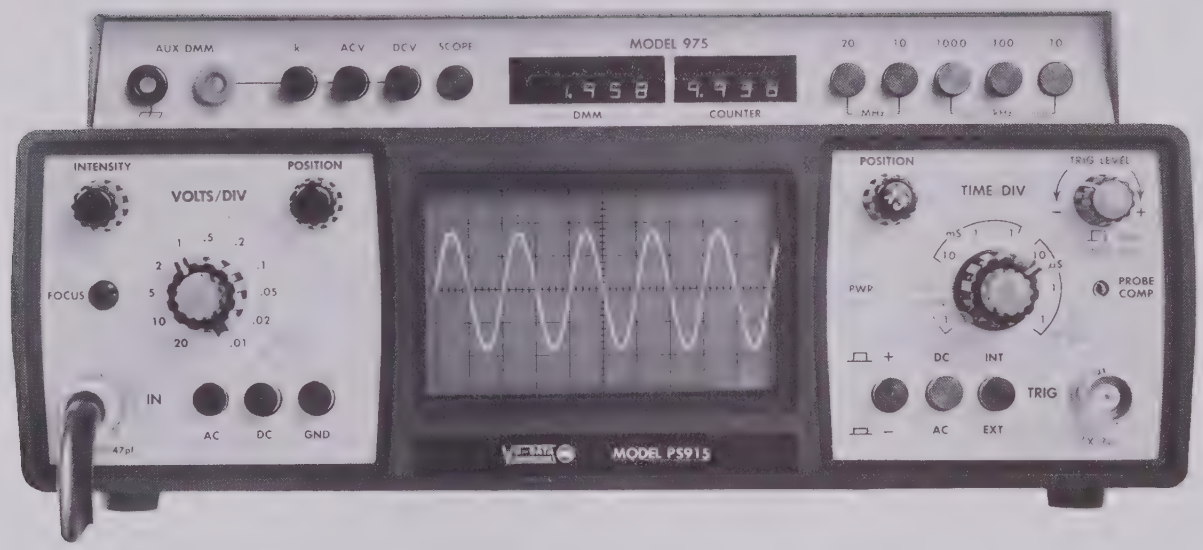


Figure 1-2. Front Panel Controls for Model PS915/975

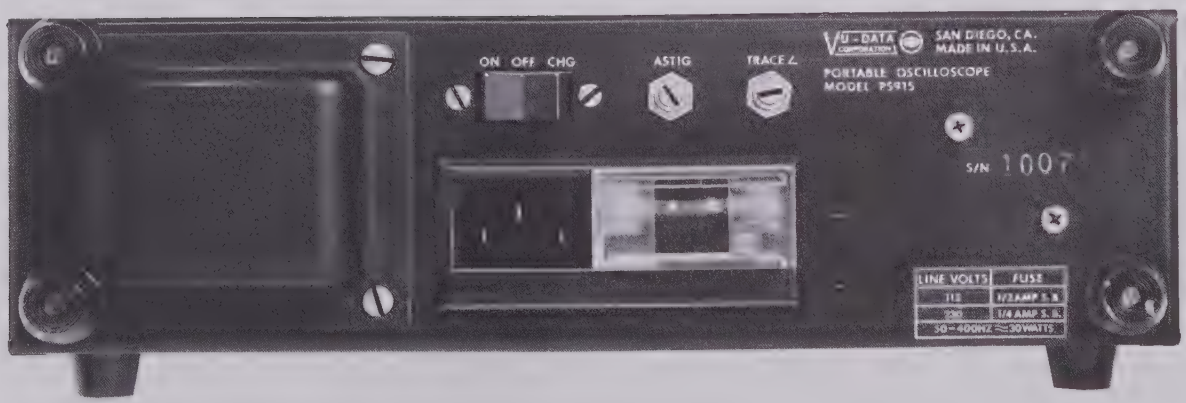


Figure 1-3. Rear Panel Controls for Model PS915

amplitude, was then divided by $2\sqrt{2}$ (or 2.828) to arrive at the RMS equivalent. Now, with the Model 975 DMM AC converter (calibrated in terms of RMS), the RMS value of a displayed sine wave can be automatically measured and displayed directly in the form of a digital readout.

In a similar fashion, the frequency of a displayed signal can be read out directly by the Model 975 Counter instead of the operator having to calculate its frequency by observing how many cycles occur per division and dividing this number by the calibrated sweep rate control setting.

And finally, the convenience of the Model 975 with its combination DMM and counter is further emphasized by the fact that the DMM and counter serve as built-in scope attenuator and sweep rate calibration verification tools, respectively.

1-13. The Model PS915/975 DMM/Counter-Mini-scope includes three separate measurement displays: a 3 1/2 digit display for the DMM, a 4 digit display for the frequency counter and a 6 x 10 div CRT display for the oscilloscope. Calculator size LED's are employed as the digital displays. They afford the smallest possible total package, while at the same time providing adequate viewability, considering a scope operator is generally observing the CRT display at close range to determine divisions of deflection of the waveform on the CRT.

1-14. Key operational features for each of the DMM, counter and scope are described below:

MINI-SCOPE: The basic features of the Model PS915 Mini-scope are described in paragraph 1-8, and basic specifications are included in paragraph 1-22. The important point is that the scope includes the circuitry to provide information to the Model 975 DMM/Counter for digital display of the AC or DC voltage, and frequency, of the displayed waveform.

In the case of voltage, the DMM is programmed to measure AC volts or DC volts by the AC/DC input coupling selector push buttons, assuming the "SCOPE" push button on the DMM has been depressed. The scope input impedance is 1 Mohm, so either a X1 or X10 probe may be employed.

Relative to frequency, the scope provides the counter with trigger pulses from its horizontal circuit trigger generator. These enable the counter to display the frequency of any signal that is synchronized on the CRT in the "internal trigger" mode. In the "external trigger" mode, the scope trigger generator pulses represent the frequency of the external trigger signal, and the counter displays that frequency. This latter feature satisfies the requirement for a dual-trace scope in many applications where the second trace might be displayed only as a frequency reference for the first, or main trace. With the Model PS915/975, this frequency information is displayed in digital form on the counter rather than as a waveform on the second trace of a dual-trace scope.

DMM: The auto-ranging DMM will measure and display average AC volts (calibrated in terms of RMS), DC volts or Kohms through its auxiliary input connector; input impedance is 10 Mohms. If the "SCOPE" mode is selected on the DMM, it will then indicate the RMS value of a sine wave displayed on the CRT, or

it can indicate the DC component of the displayed AC signal, or it can indicate the value of a DC level displayed on the CRT. In the "SCOPE" mode, the DMM is programmed for AC or DC by the scope input coupling selector.

COUNTER: As previously discussed, the frequency counter is activated by the scope trigger generator pulses. In the "internal trigger" scope mode, the counter displays the frequency of the synchronized displayed waveform. It is virtually immune from the input sensitivity problems normally associated with other frequency counters because the scope trigger generator pulses are always of a constant amplitude.

In the "external trigger" scope mode, the counter displays the frequency of the signal connected to the external trigger input BNC, whether a synchronized waveform is displayed on the CRT or not. In this application, the scope trigger level must be adjusted properly, but this can be verified by the presence of a synchronized CRT display, or a bright base line in the absence of a synchronized signal.

Period measurement capability is not included in the counter since the CRT display with its calibrated time base provides a ready measurement of the period of a signal.

1-15. PHYSICAL DESCRIPTION

1-16. The Model PS915/975 DMM/Counter-Mini-scope is comprised of two self-contained instruments, Model PS915 Mini-scope and Model 975 DMM/Counter. The Model 975 DMM/Counter can be ordered only in conjunction with the Model PS915 Mini-scope; the Model PS915 Mini-scope can be ordered separately. Model PS915 is comprised of: (1) a master board assembly which includes all vertical, trigger and power supply circuitry, (2) a plug-in assembly which includes all major horizontal circuitry, and (3) the CRT assembly. The Model 975 DMM/Counter is included on a single printed circuit board which is plug-in compatable with the Model PS915 Mini-scope. The Model 975 DMM/Counter derives its power supply voltages, programming logic and scope signal inputs from the Model PS915 Mini-scope. See Figure 1-4.

1-17. All major circuitry consists of standard off-the-shelf discrete components and integrated circuits of U.S. origin. Silicon semi-conductors, tantalum capacitors and MOS integrated circuits are employed to increase reliability. All principal components, voltage levels and test points are identified by reference designators and symbols; all diodes and tantalum capacitors are identified for polarity.

1-18. Front and rear panel controls are coordinated for ease of operation. Refer to Figures 1-2 and 1-3, respectively, and to Section III of this manual for a detailed explanation.

1-19. A fully shielded 4 cm x 6 cm flat faced, rectangular CRT is provided and secured rigidly within the CRT assembly. The external graticule is black lined and non-illuminated. It includes an 8 x 10 major division area. Each 1/4 inch major division is divided into 5 minor divisions. Graticule area is 1.5" (vertical) x 2.5" (horizontal).

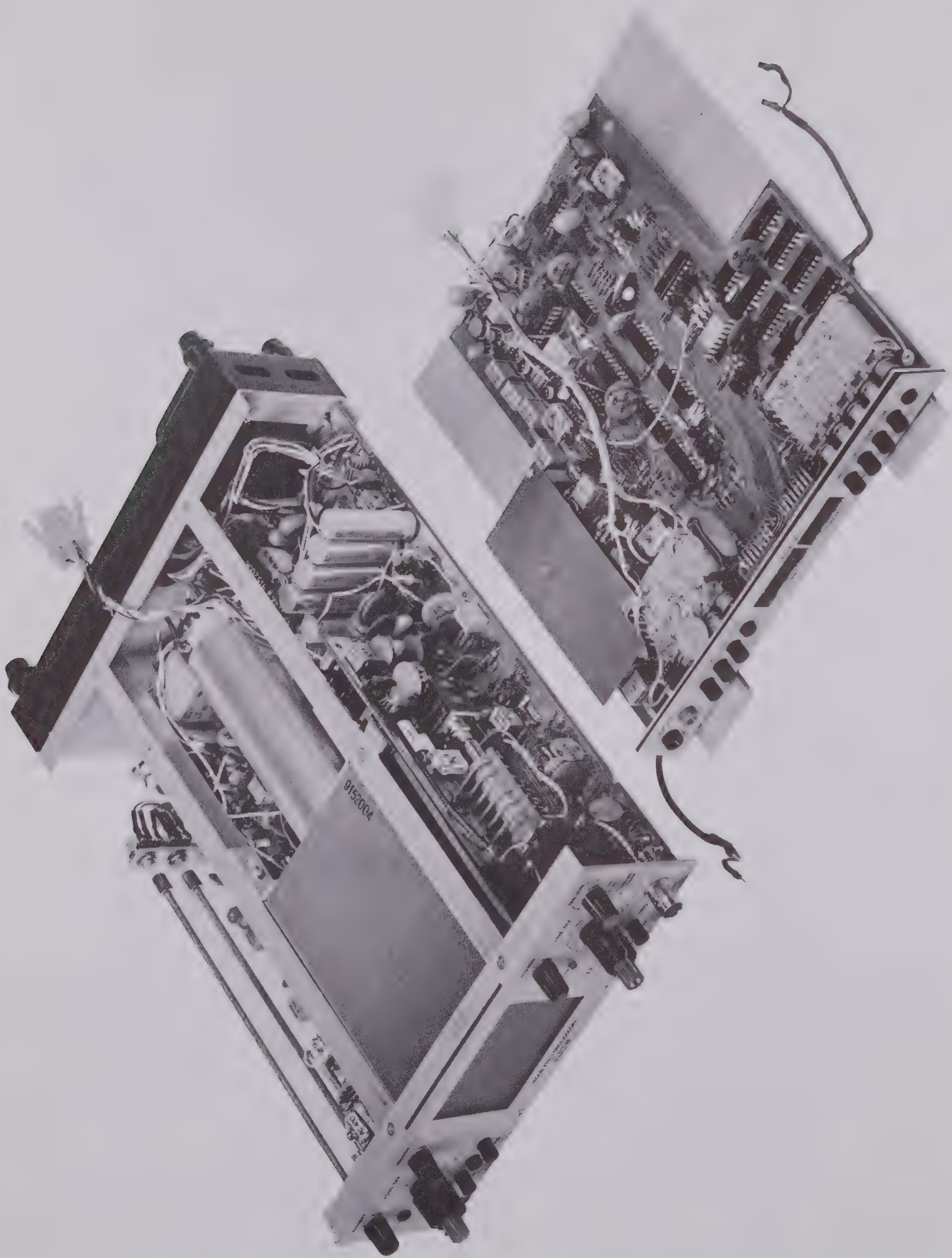


Figure 1-4. Sub-Assemblies Comprising Model PS915/975

1-20. The optional battery pack is field installable, and mounts to any PS915 bottom panel via heavy-duty mounting hardware. Electrical interface with the unit is accomplished through the external DC source input connectors on the bottom panel. The battery pack includes the battery, battery housing, and trim cover. Necessary battery recharging circuitry is contained within the basic PS915. See Figure 1-5.

1-21. All units may be rack mounted by installing the optional rack mount kit. Refer to paragraph 1-27 and Figure 1-5.

Figure 1-5. Bottom Panel View of PS915/975 with Battery Pack Option Installed

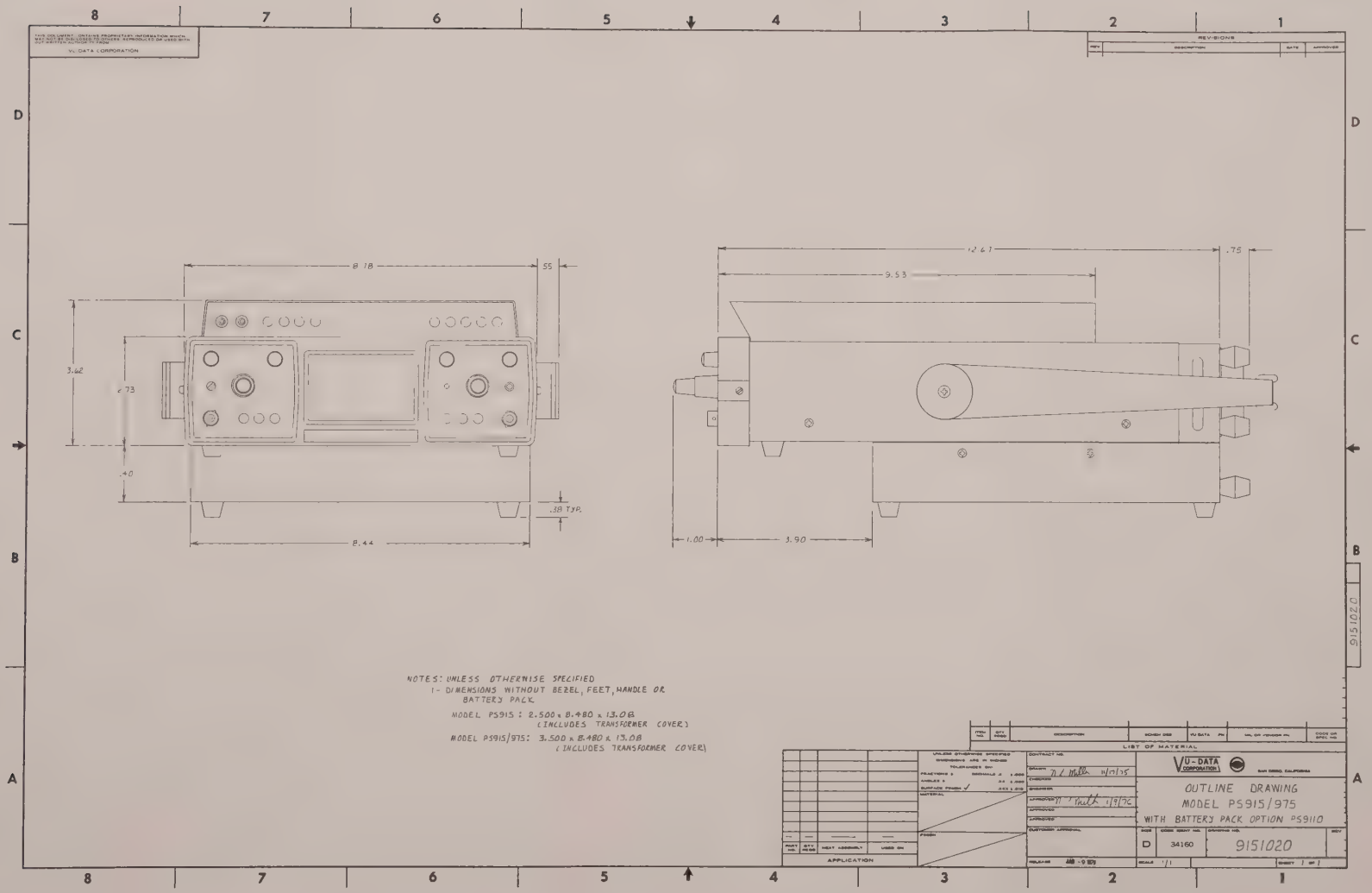


Figure 1-6. Dimensional Outline Drawing

1-22. SPECIFICATIONS

PS915 MINI-SCOPE

VERTICAL DEFLECTION

BANDWIDTH: DC to greater than 20 MHz within 3dB.
COUPLING: AC, DC or Ground, selectable. Low frequency limit with AC coupling is less than 2 Hz.
RISETIME: 17.5 nsec.
DEFLECTION FACTOR: 10 mV/div to 20 V/div in 11 calibrated ranges, 1-2-5 sequence; all ranges accurate to within 3% with vernier in Calibrate position. Vernier: Continuously variable between ranges; extends maximum deflection factor to approximately 50 V/div.
INPUT R AND C: 1 Mohm within 2% paralleled by approximately 47 pF.
MAXIMUM INPUT VOLTAGE: 400 V (DC + peak AC).

HORIZONTAL DEFLECTION

TIME BASE: 100 nsec/div to 10 msec/div in 6 calibrated decade ranges; all ranges accurate to within 3% F.S. with vernier in Calibrate position. Vernier: Continuously variable between ranges; extends slowest sweep rate to approximately 100 msec/div.
X5 MAGNIFIER: Expands sweep rate selected by factor of 5 (extends fastest sweep rate to 20 nsec/div); accurate to within 5% F.S., with vernier in Calibrate position.
EXTERNAL INPUT:
Bandwidth: DC to greater than 50 KHz within 3dB.
Coupling: DC.
Deflection Factor: 100 mV/div to 1 V/div in 2 calibrated ranges; both ranges accurate to within 3% F.S. with vernier in Calibrate position.
Vernier: Continuously variable between ranges; extends maximum deflection factor to approximately 10 V/div.
Input R and C: 1 Mohm within 2% paralleled by approximately 25 pF.
Maximum Input Voltage: 200 V (DC + peak AC).

TRIGGER

MODES: Automatic or normal, with trigger level adjustment; "+" or "-" slope selection; internal or external. Automatic operation is functional above 40 Hz, and provides a bright baseline at all sweep rates with no input.
COUPLING: AC or DC for both internal (automatic or normal) and external triggering.
AMPLITUDE REQUIREMENTS: 0.4 div deflection internal or 200 mV external to 1 MHz, increasing to 1 div deflection internal or 1 V external at 20 MHz. Requirements increase below 40 Hz with internal or external AC coupling.
INPUT R AND C (EXTERNAL TRIGGER): 1 Mohm within 2% paralleled by approximately 47 pF.
MAXIMUM INPUT VOLTAGE: 200 V (DC + peak AC).

CRT

CRT: Flat-faced rectangular with 6 x 10 div display area; each div is 1/4 inch. CRT uses low-power filament to enhance battery operation. P31 phosphor normally supplied.
GRATICULE: Black; vertical and horizontal centerlines marked in 5 minor divisions per major 1/4 inch division.

ENVIRONMENTAL (DMM/COUNTER INCLUDED)

AMBIENT TEMPERATURE: Operating: 0°C to +50°C.
Non-operating: -55°C to +75°C without batteries; -40°C to +60° with batteries.
Charging: +5°C to +40°C.
ALTITUDE: Operating: 15,000 feet maximum.
Non-operating: 50,000 feet.
SHOCK AND VIBRATION: Will withstand the shock and vibration conditions encountered in normal commercial shipping and handling.
HUMIDITY: Will operate in up to 95% relative humidity, non-condensing.

GENERAL

PROBE COMPENSATOR/AMPLITUDE CALIBRATOR: 1 V p-p accurate to within 3%, approximate 1 KHz pulse waveform. Output impedance approximately 10 Kohms.
PROBES: Standard oscilloscope probes can be employed (passive, less than 80 MHz bandwidth). One 3 ft. alligator clip probe normally provided. Option PS9008 Switchable 10:1/1:1 Probe Kit available.
POWER SOURCES (DMM/COUNTER INCLUDED):
Self-contained DC source: Chassis includes provision to accept bottom panel mounted Option PS9110 Battery Pack, which provides up to 2.5 hours of operating time; recharging circuitry is included within chassis. Internal recharging circuit has current limiting to protect batteries from overcharge.
External DC source: Bottom panel mounted jack allows unit to be operated from external DC source of 10 V to 16 V, 1.4 amps maximum.
External AC source: Operates from an external AC source of 100 V, 120 V, 220 V or 240 V $\pm$ 10% (rear panel selectable); 50 Hz to 400 Hz; 35 watts maximum.
DIMENSIONS AND WEIGHTS (DMM/COUNTER INCLUDED):
Height: 2.5" (6.35 cm); add 1.0" (2.54 cm) for DMM/Counter; add 1.0" (2.54 cm) for Option PS9110 Battery Pack.
Width: 8.5" (21.59 cm).
Depth: 12.5" (31.75 cm).
Weight: 9 lbs (4.1 kg); add 1 lb (0.5 kg) for DMM/Counter; add 6 lbs (2.7 kg) for Option PS9110 Battery Pack; add 5 lbs (2.3 kg) for shipping.

975 DMM/COUNTER

DMM

OPERATING MODES:
"AUX DMM": Selectable AC volts, DC volts and Ohms using DMM input terminals.
"SCOPE": AC volts and DC component of signal displayed on CRT using scope BNC input connector; scope AC/DC input coupling selector switch programs DMM for AC or DC, respectively.
FULL SCALE RANGES:
AC and DC: 1.999, 19.99, 199.9 and 1000. volts; AC is average reading, calibrated in terms of RMS.
Ohms: 1.999, 19.99, 199.9 and 1999. Kohms.
MAXIMUM INPUT/OVERLOAD VOLTAGE:
AC and DC: 1000 V (DC + peak AC); 400 V (DC + peak AC) using scope input.
Ohms: 50 V (DC + peak AC).
RANGING: Automatic; up-ranges at 1999 and down-ranges at 0100. Display flashes in "Ohms" mode during overrange condition.
ACCURACY:
AC: Within 0.5% of reading $\pm$ 5 digits.
DC and Ohms: Within 0.5% of reading $\pm$ 1 digit.
INPUT IMPEDANCE: 10 Mohms; 1 Mohm using scope input.
AC BANDWIDTH: 30 Hz to 5 KHz.
POLARITY: Automatic.
OHMS CONVERTER TEST CURRENTS: 1 mA, 100 uA, 10 uA and 1 uA.
DC NORMAL MODE REJECTION: 60 dB minimum at 60 Hz.
GROUNDING: DMM signal low tied to scope chassis.

COUNTER

INPUT CONFIGURATION: Counter measurement is frequency of synchronized signal displayed on CRT in scope "internal trigger" mode, or frequency of external signal in scope "external trigger" mode. Mode, level, slope polarity and input coupling selection provided by scope trigger controls.
FULL SCALE RANGES: 9.999 KHz, 99.99 KHz, 999.9 KHz, 9.999 MHz and 20.00 MHz.
RANGING: Manually selected; display flashes during out-of-range condition; 100% overrange capability provided.
ACCURACY: Within 0.1% of reading $\pm$ 1 digit.
GATE TIMES: 1 second for 9.999 KHz range and 100 msec for all other ranges.
SENSITIVITY: Counter triggered by constant amplitude pulses from scope horizontal circuit trigger generator over DC to 20 MHz range; hence, counter sensitivity for any waveform is same as scope trigger amplitude requirements. Optimum sensitivity is 10 mV p-p (3.5 mV RMS) at 20 MHz.
MAXIMUM OVERLOAD VOLTAGE: 200 V (DC + peak AC).
INPUT IMPEDANCE: 1 Mohm within 2% paralleled by approximately 47 pF.

GENERAL

DISPLAY: Separate 4 digit, magnified calculator size displays provided for DMM and counter.
TIME BASE: DMM and counter operate from a crystal controlled 3.2768 MHz clock.

AMBIENT TEMPERATURE: See scope specifications. DMM accuracy applies at 25° C ± 5° C and is derated 0.1% of reading per 10° C.
OTHER ENVIRONMENTAL: See scope specifications for altitude, shock and vibration, and humidity.
POWER SOURCES: See scope specifications.
DIMENSIONS AND WEIGHTS: See scope specifications.

1-23. ACCESSORIES

1-24. Standard accessories included with each unit at time of shipment are listed in paragraph 1-10.

1-25. The Models PS915 Mini-scope and 975 DMM/Counter include a variety of optional accessories which are available to the user to assist his application where required. These include a switchable 10:1/1:1 probe kit, battery pack, viewing hood for display enhancement under high ambient light conditions, rack mount kit, accessory pouch, and P-7 phosphor for use with low frequency phenomena. Refer to paragraph 1-27 for a detailed listing of these optional accessories.

1-26. ORDERING INFORMATION

1-27. A tabulation of all models and optional accessories follows. Consult the Vu-data Corporation factory directly or your local Vu-data sales office for current price and delivery information.

Model PS915 Mini-scope

Model PS915/975 DMM/Counter-Mini-scope

Model 975 DMM/Counter (Must be purchased in conjunction with Model PS915 Mini-scope.)

Option PS9008 Switchable 10:1/1:1 Probe Kit

Option PS9110 Battery Pack (Secures to bottom panel and is field installable.)

Option PS9111 Viewing Hood (Secures to CRT bezel to shield display from high ambient light conditions.)

Option PS9112 Rack Mount Kit (For use in mounting Model PS915 Mini-scope or Model PS915/975 DMM/Counter-Mini-scope in RETMA cabinet; height: 5.25" (13.34 cm); width: 19.0" (48.26 cm). Specify "PS9112-1" for Model PS915 and "PS9112-2" for Model PS915/975 combination.)

Option PS9115 Accessory Pouch (Employed for storage of accessories; secures to top cover of Model PS915 Mini-scope and is not available with Model PS915/975 DMM/Counter-Mini-scope combination.)

Option PS9117 P-7 Phosphor (Substituted in place of P-31 Phosphor and enhances display of low frequency phenomena.)

SECTION II

INSTALLATION

2-1. INSPECTION UPON RECEIPT

The Model PS915/975 is aligned, calibrated, and tested under severe environmental conditions prior to shipment. The instrument is therefore ready for immediate use upon receipt. The following checks should be made however, to assure that the instrument has suffered no damage in shipment.

a. A visual inspection of the shipping container should be accomplished prior to acceptance from the carrier. If extensive damage of the shipping container is evident, a description of the damage should be noted on the carrier's receipt and signed by the carrier's agent. If damage is not apparent until the instrument is unpacked, a claim for concealed damage should be placed with the carrier within 15 days of receipt. All shipping containers and filler material must be kept for inspection.

b. A visual inspection for damage should be accomplished upon removing the instrument from the shipping container. Remove the top and bottom covers and check for loose or broken components.

2-2. BATTERY OPERATION

The battery pack is composed of two 6 volt batteries connected in series to supply 12 volts DC. The individual cells are completely sealed and require no maintenance other than periodic charging. Over (200) charge-discharge cycles can be expected before the batteries must be replaced. To operate the PS915/975 on batteries, unplug the AC power cord and use the switch on the rear of the instrument to control power on-off. To recharge the batteries connect the AC line cord to the instrument and the power line, and place the rear panel switch to the charge position. The battery pack should be charged for 16-20 hours for full recovery. The battery pack is trickle charged when the PS915/975 is operated from the AC line.

4.5 AmP HRS.

2-3. To install the battery pack to the bottom cover of the PS915/975, perform the following steps:

1. Unplug the AC power cord and place the AC power switch (located on the rear panel) to the off position.

2. Place the PS915/975 on its top on a flat surface with the front panel facing towards you.

3. Remove the two protective plastic caps located adjacent to the external power information decal.

4. Remove the two 6-32 flathead screws from the bottom cover (located adjacent to the rear bottom feet), save these screws for future usage.

5. Place the battery pack on a flat surface, four cabinet feet up and slots away from you.

6. Remove the four 4-40 screws and No. 4 washers from the sides of the battery pack and lift off the cover.

7. Remove the bag containing the fastening hardware and place the battery pack on the bottom cover of the PS915/975. The rear feet of the bottom cover will protrude through the two large holes of the battery pack.

8. Fasten the battery pack to the PS915/975 with the supplied hardware, four No. 6 screws and washers.

9. Remove the battery connector from the insulated transport standoffs and insert into the PS915/975 receptacle located to the left. Correct polarity must be observed (ground pin towards left), do not short out the connector terminals.

10. Install the battery pack cover with the slots towards the rear and secure with the four 4-40 screws and No. 4 washers.

SECTION III

OPERATION

SECTION III

OPERATION

3-1. FRONT PANEL, CONTROL FUNCTIONS AND CONNECTIONS

The front panel divides into three sections:

1. The left side is the VERTICAL Section and CRT Controls.
2. The right side is the HORIZONTAL Section.
3. The top is the DMM/COUNTER Section.

3-2. VERTICAL SECTION

a) IN — BNC connector - signal input connector for vertical CRT display and for the DMM when the SCOPE button on the DMM is depressed. Impedance is 1 Megohm paralleled by approximately 47pf.

b) AC-DC-GND — Push-buttons - selects the mode of coupling into the vertical CRT display and into the DMM when the DMM SCOPE button is depressed. DC gives direct coupling, AC is capacitive coupling, and GND grounds the input to the instrument without grounding the input signal.

NOTE: Do not exceed 400V DC + peak AC when in the AC mode.

c) VOLTS/DIV — Eleven position switch which selects calibrated vertical display factors from 10mV to 20V per division in a 1-2-5 sequence. Vernier: Red concentric knob provides a variable vertical display for overlapping of vertical ranges and extends the 20 volts/division range to approximately 50 volts/division.

NOTE: For accurate, calibrated vertical measurements, the vertical vernier (red knob) must be in the CAL detent position (CW).

d) POSITION — Positions the CRT display vertically.

e) INTENSITY — Controls the intensity of the CRT display.

NOTE: Do not leave the intensity control in the maximum clockwise direction with a continuous display for a long period of time as phosphor burns on the CRT will result.

f) FOCUS — Controls focus of CRT beam.

3-3. HORIZONTAL SECTION

a) TIME/DIV — Eight position switch provides six calibrated sweep ranges from .1 microsecond to 10 milliseconds per division and 2 X-axis ranges of .1 volt and 1 volt per division. Vernier: Red concentric knob provides a variable sweep rate for overlapping ranges and extends the 10 ms/div range to approximately 100 ms/div. In the X axis positions, the vernier extends the .1 or 1V/div range down to approximately 1 or 10V/div. The vernier is calibrated when in the fully clockwise position.

b) POSITION — Positions the CRT display horizontally.

c) X5 — Pulling the POSITION knob out magnifies the horizontal portion of the display by a factor of 5.

d) PWR — Green LED indicates power switch in the ON position.

e) TRIG (X IN) — BNC connector used for external trigger signal and X-axis signal. Impedance is 1 Megohm.

f) INT/EXT — Push-push switch which selects a trigger signal from the TRIG BNC or the internal vertical signal.

g) DC/AC — Push-push switch which couples the signal selected by the INT/EXT switch either direct or capacitively to the trigger circuitry.

h) +/- — Push-push switch which selects the slope of the signal used for triggering.

i) TRIG LEVEL — Rotating the pot moves the trigger point up or down the slope selected by +/-.

NOTE: The 975 counter displays the frequency of the signal used as the scope trigger signal, which can be INT/EXT, AC/DC, +/-. The scope must be stablely triggered in order to get a meaningful reading from the counter.

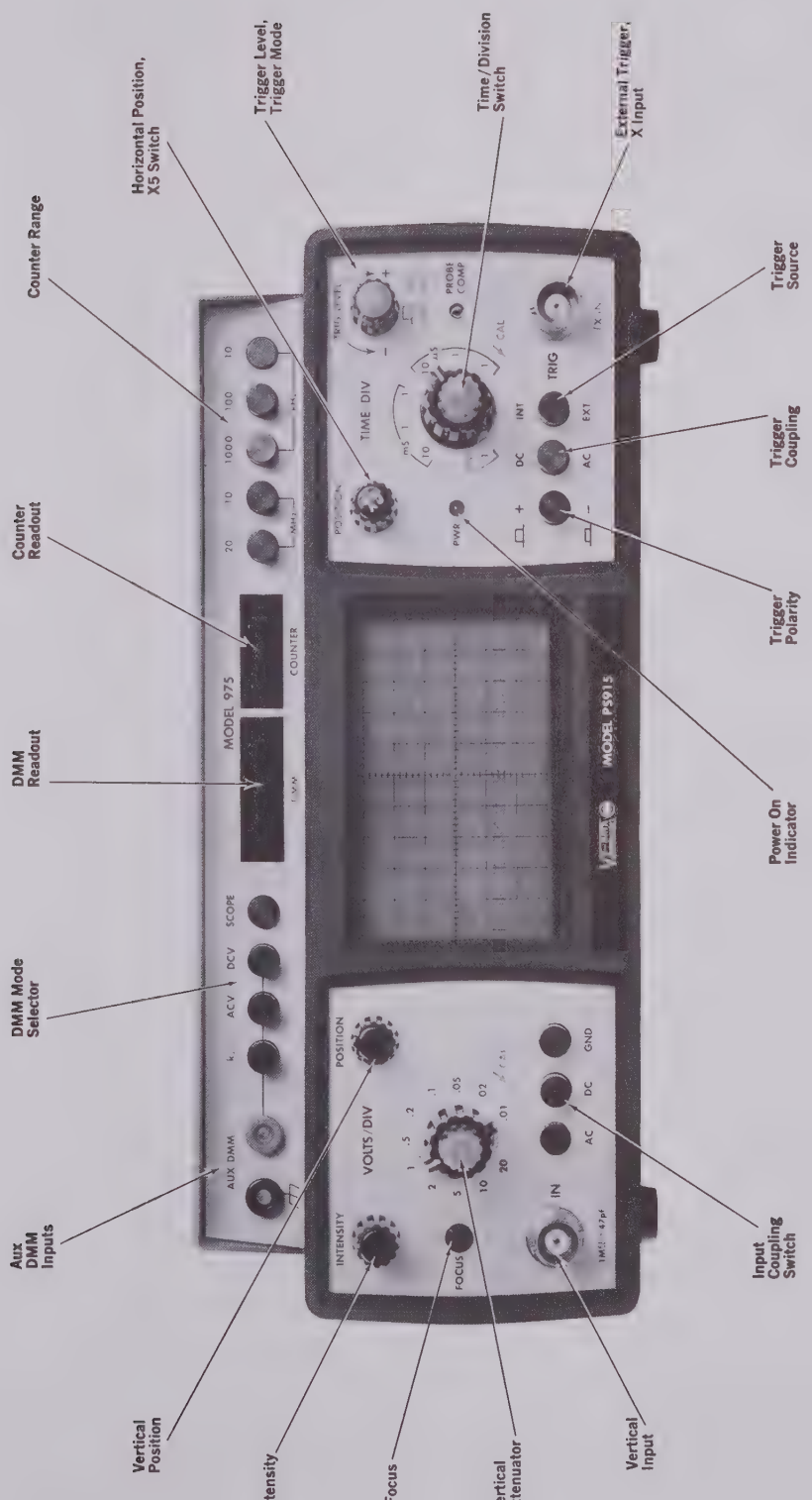


Figure 3-1. Location of Front Panel Operating Controls Model PS915/975

At high frequencies, the scope may appear to have a stable trace, but the counter will not be giving the proper readout. The TRIG LEVEL control should be used as a counter sensitivity adjustment to properly sync to the signal.

j) AUTO/NORM — When the TRIG LEVEL knob is pushed in, the auto trigger oscillator provides a reference baseline in the absense of a trigger signal. Pulling the knob out deactivates the auto oscillator and the scope will sweep only if a trigger signal is detected.

k) PROBE COMP. — A 1 volt peak-to-peak square wave at 1 KHz to be used for compensating input probes.

3-4. DMM/COUNTER SECTION

a) AUX DMM — Mini-banana jacks are the input to the DMM when in the Kohm, ACV or DCV positions of the DMM switch. Impedance is 10 Megohms.

b) KOHM — Push-button switch puts the DMM in Ohms measurement mode using the AUX DMM input connector.

c) ACV — Push-button switch puts the DMM in AC volts measurement mode using the AUX DMM input connector.

d) DCV — Push-button switch puts the DMM in DC volts measurement mode using the AUX DMM input connector.

e) SCOPE — Push-button switch puts the DMM into the AC or DC volts measurement mode selected by the vertical switches AC-DC-GND. Input to the DMM is the signal at vertical IN connector. Input impedance is the scope input impedance, 1 Megohm paralleled by approximately 47pf.

CAUTION: Remember the DMM is part of an oscilloscope, and the scope signal low is chassis ground. Leaving the scope tied to ground and trying to use the AUX DMM inputs to measure a voltage not referenced to the same ground will short the system.

When measuring a floating voltage with the AUX DMM leads, you must use the same procedures as used when floating an oscilloscope.

f) MHz - KHz — Five push-button switches to select the counter range. Full scale ranges are 10 KHz (9,999 Hz) to 20 MHz (19.99 MHz).

3-5. REAR PANEL, CONTROL FUNCTIONS AND CONNECTIONS

a) TRACE < — Adjusts the horizontal angle of the trace relative to the graticule.

b) ASTIG — Adjustment for control of astigmatism.

c) ON-OFF-CHG — Rocker switch to control power to the instrument. In ON position, the scope is powered, and if the AC line is connected, the battery is recharged. In OFF position, no power is supplied to any part of the instrument. In CHG position, power is supplied only to the battery charger.

d) POWER LINE MODULE — This module incorporates the AC line plug, line fuse and voltage selector. The power cord must be unplugged, then the plastic door slides to the side for access to the line fuse and voltage selector plug.

CAUTION

Do not reverse polarity connections to the EXT DC POWER jacks, or the charger protection fuse will be blown and must be replaced.

3-6. FIRST TIME OPERATION

The following procedure is intended to familiarize the operator with the operating controls and also as an operational check of the instrument.

a) Inspect the power line module for proper line voltage and fuse size, then connect the line cord to the power module and AC power outlet. Push the power switch to the ON position and allow several minutes for warmup.

b) Set the front panel controls as follows:

AC-DC-GND	DC
VOLTS/DIV	.5V/div, vernier to CAL
VERT POSITION	Midrange

INTENSITY	Clockwise
FOCUS	Midrange
TIME/DIV	1ms/div, vernier to CAL
HORIZONTAL POSITION	Midrange
X5	IN
INT/EXT	INT
DC/AC	DC
+/-	+
TRIG LEVEL	Midrange
AUTO/NORM	IN
TRACE <	Midrange
ASTIG	Midrange

If instrument is equipped with 975 DMM/COUNTER:

Kohm-AC-DC-SCOPE	SCOPE
COUNTER RANGE	10 KHz

c) Connect the direct input cable to the vertical IN BNC and the high (red) clip to the PROBE COMP output jack. Adjust TRIG LEVEL if necessary for a stable trace. You should observe a square wave approximately 2 divisions in amplitude, with a period of 1 division. Reduce the intensity and adjust the focus for a suitable display.

d) If the 975 DMM/COUNTER is installed it should be displaying a readout in the DMM window that is the d.c. average value of the PROBE CAL signal input, or approximately 0.6 volts. The COUNTER should be reading the PROBE CAL frequency of 1 KHz.

e) Rotate the vertical vernier CCW and note the square wave decreases in amplitude. Return vernier to the CAL detent position.

f) Rotate the vertical position control so that the square wave is symmetrical about the Y-axis centerline. Set the AC-DC-GND switch to AC and note the downward shift of the square wave due to the input now being AC coupled. Observe that the DMM readout has changed and is approximately 0.5 volts. Switch to GND and note that the square wave is replaced by a line. Observe that the DMM readout has changed to 0V, and the COUNTER readout is 0 Hz. Adjust the rear panel TRACE < control so that the trace is parallel with the graticule center-line.

g) Set the TIME/DIV switch to the X-Y position 1V/div. The CRT display should be a spot in the center of the screen, since there is neither Y axis or X axis input. Reduce the INTENSITY until the spot is just visible. Adjust the FOCUS and rear panel ASTIG controls to achieve the smallest, most symmetrical spot.

h) Move the input connector from vertical IN to TRIG (X IN). Set the INT-EXT button to EXT. A horizontal line 1 division long should appear. Rotate the horizontal POSITION control to move the line left and right on the CRT. Rotate the TIME/DIV vernier and confirm the length of the line decreases. Return vernier to CAL position.

i) Set the TIME/DIV switch to 1ms/div. The horizontal sweep should start again. Pull the AUTO-NORM control out, and rotate the same control (TRIG LEVEL) to make the sweep appear and disappear when the level setting is greater than the signal amplitude. With the sweep running, set the INT-EXT switch to INT and the sweep should stop. Push the AUTO-NORM control in and the sweep will start again. Move the input connector from EXT to vertical IN.

j) Switch the vertical AC-DC-GND switch to DC, and adjust the TRIG LEVEL control if necessary, for a stable trace. Operate the TRIG +, - switch and confirm the trace starts on the + or - edge of the square wave.

k) Pull the X5 (Horizontal POSITION) knob out, and note the vertical display is magnified by a factor of 5. Push the X5 knob in, and rotate the TIME/DIV vernier control CCW noting the sweep time increases by approximately 10.

3-7. GENERAL OPERATION

3-8. INPUT SIGNAL PROBES

When 10X probes are used, they must be compensated for the time constant associated with the input circuitry. The PROBE CAL output is used to provide the 1KHz square wave signal. In using other square wave sources, it is important not to exceed a frequency of about 5 KHz or the amplitude of the trace will change, making proper probe compensation difficult.

3-9. VERTICAL DISPLAY

The vertical display (Y axis) is the signal connected to the IN BNC, coupled by the AC-DC-GND switches to the VOLTS/DIV attenuator switch. The vernier in the Volts/Div switch gives overlapping of the calibrated ranges. The trace is moved up or down on the CRT by the POSITION pot.

3-10. HORIZONTAL DISPLAY

The horizontal display (X axis) is the time base or waveform selected by the TIME/DIV switch. The vernier in the TIME/DIV switch increases the sweep times by a factor of 10 to give overlapping of the calibrated ranges. When in the VOLTS/DIV positions, the vernier attenuates the waveform coming in the TRIG (X IN) BNC by approximately 10 to give a total range of from 100mV to 10V/div for the X axis mode. The trace is moved left or right by the POSITION control, and pulling the knob magnifies the sweep time by X5.

3-11. TRIGGERING

The trigger signal is the signal displayed on the vertical display if INT is selected or from the TRIG BNC when in EXT. The signal is then AC or DC coupled, and the slope is selected by + or -. The trigger point on the slope is selected by TRIG LEVEL, and pulling this control out deactivates the AUTO oscillator, which provides a reference baseline in situations when no trigger signal is present.

3-12. CRT CONTROLS

The brightness of the trace is controlled by the INTENSITY control. At high intensities, the FOCUS control may need re-adjusting. The sharpest display is provided by adjusting the FOCUS and ASTIGMATISM control while at a medium intensity level. The angular position of the sweep relative to the graticule is controlled by the TRACE< control.

3-13. DMM OPERATION

The DMM readout is a 3 1/2 digit display whose value is Kilohms, volts RMS, or volts DC, depending on the function selected. When the SCOPE function is selected, the input of the DMM is tied to the input of the oscilloscope, and the readout will be VRMS or VDC depending on the setting of the scope AC-DC-GND switch. In this mode, the scope input limits the input to the DMM to 400V (DC + peak AC).

If KOHMS, AC or DC is selected, the input of the DMM is connected to the AUX DMM input jacks. (The low jack is tied to chassis, as in the oscilloscope.) Using this input, the voltmeter can be used up to 1000V, and its input impedance is 10Megohm instead of the 1Megohm of the scope input. The DMM is auto-ranging in all functions.

3-14. COUNTER OPERATION

The COUNTER readout is a 4 digit display that reads up to 9999 then blinks to indicate over-ranging. A 5 position switch selects full scale ranges of 9.999 KHz, 99.99KHz, 999.9KHz, 9.999MHz and 20.00MHz. The signal to the counter comes from the trigger comparator in the 915 horizontal circuitry, and the frequency displayed is the frequency of the scope trigger signal.

SECTION IV

THEORY OF OPERATION

4-1. GENERAL

The Model PS915 Portable Oscilloscope circuits are contained on two (2) printed circuit boards. The main board includes vertical deflection, triggering, blanking, horizontal output, power supply and battery charger circuits. The sweep generation and X amplifier circuitry are located on the small plug-in sweep amplifier board. Refer to Block Diagram Figure 4-2 and Schematic Diagram 9151001.

4-2. The vertical input circuitry is designed in such a way as to provide all signal conditioning necessary to couple and scale the input signal. The required impedance transformations are accomplished by the input and output buffers and appropriate attenuation ratios are achieved by the A and B Sections of the vertical attenuator. The vertical input circuitry naturally divides into three (3) parts:

1. Input Coupling and Vertical Attenuator (A Section)

2. Vertical Input Buffer

3. Vertical Attenuator (B Section) and Output Buffer

4-3. INPUT COUPLING AND VERTICAL ATTENUATOR (A SECTION)

The vertical input signal applied at BNC J402 is coupled through R276 to switch S2. S2 couples the signal through C151 for AC or direct for DC to the A Section of the vertical attenuator. S2, a three-station, interlocking, push-button switch also has a ground position which grounds the input to the vertical amplifier without grounding the signal source. S2 also switches logic lines which provide function programming for the Model 975 DMM/COUNTER. The logic lines are coupled to the 975 through Connector J5. The output of S2 also goes to a second connector, J4, which provides an input to the DMM portion of the Model 975 through a shielded wire. This places the DMM in parallel with the input to the oscilloscope behind the input coupling. Resistor R275 simulates the loading that the DMM presents at J4 in the absence of the Model 975. If the Model 975 is used with the oscilloscope, R275 is removed. The A Section of the vertical attenuator (switched by S601) either passes the signal with no attenuation on the six most sensitive ranges or divides it by a factor of 100 on the five least sensitive ranges. R605 and R606 accomplish the 100:1 attenuation at low frequencies. C602 and C604 compensate the attenuator at high frequencies. C603 maintains a constant input capacity so that an external divide by ten probe may be used.

4-4. VERTICAL INPUT BUFFER

The signal is routed through R603 to the input of the vertical input buffer. R603 in conjunction with Diodes CR28 and CR29 provide overload protection for the input buffer in the event of overload signals applied to the input. Refer to Figure 4-1 as an aid to tracing the signal flow through the vertical input buffer.

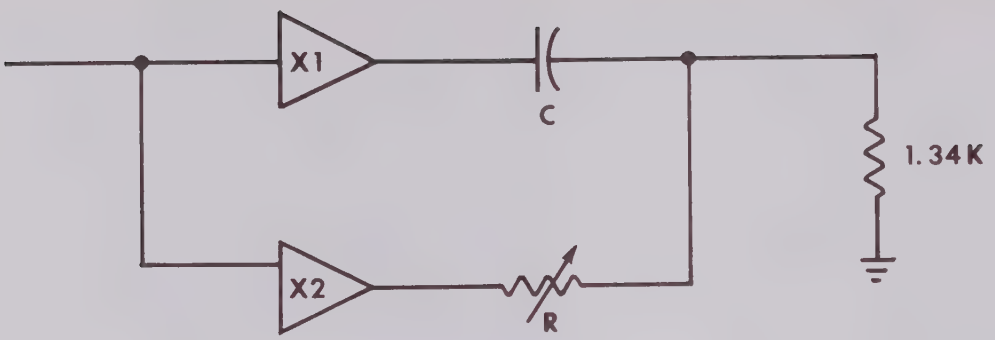


Figure 4-1. Simplified Vertical Input Buffer Block Diagram

There are two signal paths in the input buffer, a high frequency path and a low frequency path. The high frequency path consists of the X1 amplifier coupling through C to the top of the 1.34K. The low frequency path is through the X2 amplifier coupling through R to the top of the 1.34K resistor. At low frequencies the signal is given a gain of 2 by the X2 amplifier. The output signal from the X2 amplifier is passed through the resistive divider formed by the 1.34K and R. If R is adjusted so that the divider ratio is exactly the inverse of the X2 amplifier gain, then the gain to the top of the 1.34K at low frequencies is exactly 1. At high frequencies C shunts the signal from the X2 amplifier to ground through the low output impedance of the X1 amplifier so that the contribution through the X2 path is negligible. However, just as C shorts out the signal from the X2 portion of the amplifier, it also passes that portion of the signal from the X1 amplifier, thus maintaining a gain of 1 to the top of the 1.34K at high frequencies. Source follower Q38 and emitter follower Q39 comprise the X1 portion of the amplifier. Dual field effect transistor U2 and integrated circuit U3 configured as an operational subtractor serve as the X2 amplifier. Variable resistor R126 is adjusted so that the gain at low frequencies to the junction point of the capacitor and resistor exactly matches the gain to the same point at high frequencies through the X1 section of the amplifier. The 1.34K is, in fact, the series resistance of the B Section of the attenuator, composed of resistors R609-R614. An offset adjustment is provided by resistor R117 to the non-signal side of the dual FET U2 so that the output of the vertical input buffer can be adjusted to 0V DC.

4-5. VERTICAL ATTENUATOR (B SECTION) AND OUTPUT BUFFER

The B Section of the vertical attenuator consists of six resistors in series from the output of the vertical input buffer to ground. The wiper of the C deck of switch S601 picks off the various junction points of the six resistors. The resistors are weighted to give attenuation ratios that are multiples of one, two or five. From the B Section of the attenuator the attenuated signal is fed to the output buffer which consists of four sets of Darlington connected transistors Q42-Q49. The first set, Q42 and Q43, unloads the output of the B Section of the attenuator and serves to present a low driving point impedance to the gain vernier network. Q44 and Q45 serve to match the DC offset of Q42 and Q43 and also provide a low driving point impedance for the other side of the gain vernier network.

R130 is adjusted so that the DC offset difference between the emitter of Q43 and the emitter of Q45 is nulled to zero. The gain vernier network consists of a potentiometer in series with a fixed resistor, R615 and R616, respectively. The signal is continuously attenuated as R615 is varied in the counterclockwise direction. The maximum achievable attenuation of this network is 2.5. The wiper of the gain vernier pot feeds Darlington pair Q46 and Q47 which unload the gain vernier network. Darlington pair, Q48 and Q49, match the DC offset of Q46 and Q47. Two of the Darlington pairs are NPN transistors and two are PNP transistors. This is done so that the common mode output of the output buffer is biased at approximately 0V.

4-6. VIDEO AMPLIFIER AND VERTICAL OUTPUT AMPLIFIER

The signal is routed from the output buffer to integrated circuit U4, a differential-in-to-differential-out, video amplifier having a gain of approximately 30. The differential output from U4 is coupled through R187 and R199 to the vertical output stage. The output of U4 also drives a trigger conditioning amplifier which consists of Q50 and Q51 configured as a single stage differential amplifier. R158 is adjusted to bias the output of the triggering conditioning amplifier (TP1) to 0V DC. The vertical output amplifier consists of transistors Q52-Q70 and associated components. It is a differential-in-to-differential-out voltage amplifier that drives the vertical deflection plates. Local feedback is employed for gain stability and a push-pull output stage achieves low distortion at high frequencies. Transistors Q64 and Q65 are configured as a differential amplifier stage with their emitters coupled through R191. Current source transistors Q66, Q67, Q68 and Q69 provide bias current for the differential stage. The vertical position control, R405, unbalances the current sharing in Q68 and Q69 to achieve vertical positioning of the trace. R194 varies the current in current source Q70 to bias outputs Y1 and Y2 symmetrically about 0. The primary purpose of Q66 and Q67 is to increase the range of the vertical positioning control, R405. This makes it possible to position a full scale vertical trace off the screen if desired. The difference voltage applied at the bases of Q64 and Q65 is converted by the differential action of the stage into a difference current signal at the collectors of Q64 and Q65. This differential current signal is applied to complementary common base stages Q54 and Q60 on one side, and Q55 and Q61 on the other side. The outputs of the common base stages are coupled to emitter follower transistors Q53, Q59, Q56 and Q62. The emitter follower stages provide buffering for the common base stages to achieve wide bandwidth. The emitter followers drive complementary, common emitter, push-pull output stages comprised of Q52 and Q58 on one side, and Q57 and Q63 on the other. Local feedback is employed from Y1 and Y2 through resistors R163 and R172, respectively, to the inputs of the complementary common base stages. This output amplifier provides a differential voltage swing of 60V at 20MHz which is necessary to drive the vertical deflection plates. The various diodes scattered throughout the vertical output amplifier are for biasing purposes.

4-7. TRIGGER GENERATOR AND TRIGGER CONDITIONING

The trigger generator provides trigger pulses to synchronize the start of the sweep to a trigger input signal. The trigger input signal may be derived from the vertical input signal or may be supplied through the external trigger input on the front panel. Appropriate trigger signal conditioning is achieved by the trigger source, coupling, mode, slope and level controls. In general the waveforms applied to the trigger generator vary greatly in amplitude and shape. The trigger generator "squares-up" these various inputs to achieve a standardized square pulse. The external trigger signal is applied to BNC J401 and is coupled through R401 to the sweep amp board. The signal goes to the wiper of deck a of rotary switch S1, the horizontal sweep selector switch. If S1 is set to any of the six sweep ranges, the output of deck a is coupled back to the main board. This coupling through the sweep amp board is necessary since J401 is used for the horizontal input signal when the scope is used in X-Y mode. From the sweep amp board the external trigger signal is routed to the trigger source switch, S1a. S1 is a three-station, non-interlocking, push-push switch. The trigger source portion of the switch, S1a, selects internal trigger when extended and external trigger when depressed. When in the internal position, the trigger signal is taken from TP1, the output of the trigger conditioning amplifier. The output from the trigger source switch is routed through S1b, the trigger coupling switch. The trigger signal is either coupled directly when the switch is extended or AC coupled through C1 when the switch is depressed. R3 provides 1 Megohm input impedance for the external trigger signal. The trigger signal is passed through R4 to the source of field effect transistor Q1, the input to the trigger generator. R4 in conjunction with CR1 and CR2 provide protection against overload signals applied at J401. Q1 and Q2, matched field effect transistors operated as source followers, serve as the input stage of the trigger generator. Potentiometer R402 is the trigger level control and applies a variable DC voltage to the gate of Q2. This allows the user to vary the point on the trigger signal waveform at which trigger pulses are generated. The sources of Q1 and Q2 provide relatively low driving point impedances for S1c, the trigger slope switch. S1c, a double pole, double throw, phase reversing switch couples the trigger signal to Q3 or Q4, depending whether the switch is extended or depressed. When S1c is extended, the trigger signal couples to the base of Q4 and the trigger level voltage is coupled to the base of Q3. When the switch is depressed, the outputs of Q1 and Q2 reverse. The trigger slope switch is arranged so that when in the positive position the trigger pulses will be generated somewhere on the positive slope of the trigger signal. The exact point on the slope is determined by the position of the trigger level control, R402. Emitter followers, Q3 and Q4, provide low driving point impedances for integrated circuit U1, a voltage comparator. R13 and R19 provide positive feedback around U1, thus establishing a hysteresis level which must be overcome in order for the output of U1 to switch states. This hysteresis is necessary to accomplish reliable, reproducable triggering. Emitter follower Q5 establishes a low impedance reference level for U1.

4-8. COUNTER LEVEL SHIFTING

The Model PS915 can be used in conjunction with the Model 975 DMM/COUNTER. The input for the counter is derived from the trigger generator.

When the trigger source is internal, the counter counts the frequency of the displayed vertical signal and when external, the frequency of the external trigger signal is counted. The output of the trigger generator must be level shifted to standard logic levels. The output of U1 couples directly to the base of emitter follower Q19 which drives common base stage Q20. The collector of Q20 is prevented from saturating by Schottky barrier diode CR16, thus allowing the level shifter to operate at high frequencies. The collector of Q20 couples to the base of emitter follower Q21 whose emitter drives connector J1. From J1 the counter trigger signal goes via shielded wire to the input of the counter in the Model 975.

4-9. SWEEP GENERATION AND CONTROL

The major requirements for the sweep waveform are tabulated below:

1. The sweep signal must be a voltage which increases linearly with time.

2. The sweep must start only on receipt of a trigger pulse from the trigger generator or from the auto trigger oscillator.

3. The sweep must reset to some initial level after reaching a predetermined amplitude and must not start again until it has completely reset and received a new trigger signal.

The sweep control circuitry must be capable of satisfying the above requirements and must also perform the following functions:

1. The electron beam must be blanked during the time the sweep signal is being reset and unblanked during the time the sweep is ramping.

2. The auto trigger oscillator must be disabled when the sweep is triggered by the trigger generator.

All of these requisites are met by five elements of the block diagram, namely;

1. Sweep Generator

2. Auto Trigger Oscillator

3. Sweep Control

4. Hold-off Monostable Multivibrator

5. Blanking Generator

4-10. SWEEP GENERATOR

The sweep generator circuitry is located on the plug-in sweep amp board. The major components of the sweep generator are field effect transistor Q1 and integrated circuit U1.

Integrated circuit amplifier U1 is configured as an integrator with FET Q1 serving as a switch across the integrating capacitor. When Q1 is conducting, it presents a low resistance between the output and the summing junction of the integrator. This causes the output of U1 to go to a very low DC value. When Q1 is opened, the integrating capacitor is allowed to charge and the output of U1 is a linear voltage ramp. Capacitors C7 and C8 are ratio matched to within 1% and comprise two of the three integrating capacitors. C9, paralleled with variable capacitor C10, serves as a third integrating capacitor. Each capacitor is used for two sweep ranges and is switched by c deck of eight position rotary switch S1. Fixed resistors R7 and R8 function as input resistors to the integrator and are switched in and out on alternate sweep ranges by d deck of rotary switch S1. R5 and R6 also feed into the summing junction of the integrator and are driven from a voltage which can be varied by R9, the sweep vernier potentiometer. This arrangement provides for the generation of a ramp starting at 0V, the slope of which can be continuously varied over six decades. The output of the integrator is coupled through Elco pin B to the main circuit board. Thus, the sweep generator standardizes the starting point of each sweep at 0V and also controls the slope of the linear sweep. The amplitude that the ramp eventually reaches is determined by the hold-off monostable multivibrator in conjunction with the sweep control circuitry.

4-11. HOLD-OFF MONOSTABLE MULTIVIBRATOR

The hold-off monostable performs two functions. The first is to detect when the sweep has ramped to a predetermined voltage and the second is to provide a timing interval to the sweep control circuit to allow the sweep adequate time to reset. The hold-off monostable, located on the main circuit board, consists of transistors Q13-Q18 and associated circuitry. The sweep signal is applied to the voltage divider formed by R45 and R46. The divided point feeds the emitter of a common base stage, Q13. When the sweep has ramped sufficiently to drive the divided point above 0V, Q13 turns on, thus supplying base current to Q14. Q14 and Q18 and associated circuitry comprise a monostable circuit. As Q14 starts to turn on, the negative transition at its collector is coupled through CR12 and timing capacitor C21, C22 or C23 to the base of Q18. Q18 turns off causing its collector to go positive, providing increased base current to Q14. After selectable capacitor C21, C22 or C23 recharges through R56, Q18 turns on again, robbing base drive to Q14. Although not obvious from the discussion thus far, Q13 will have been turned off by the sweep control circuitry by the time the monostable has timed out. Thus, there will be no base current for Q14 from Q13. Q15 provides a logical inversion necessary for the sweep control circuitry. Q16 and Q17 are field effect transistor switches that switch timing capacitors C22 and C23, depending upon which sweep range is selected. Programming for the FET switches is derived from e deck of rotary switch S1. The collector of Q15, the output of the hold-off monostable, couples through CR10 to the input of the sweep control circuitry.

4-12. SWEEP CONTROL CIRCUIT

The sweep control circuit consists of Q10 and Q11 configured as a Schmidt trigger. The Schmidt trigger is designed in such a way so that it exhibits about 1V hysteresis at its input, the base of Q10.

The upper and lower limits of the hysteresis band are approximately -4V and -5V, respectively. The stability adjustment, potentiometer R34, is used to bias the input of the Schmidt within the hysteresis band. The negative and positive transition at the output of the trigger generator are differentiated by C8 and applied to the base of Q10. For explanation purposes consider the Schmidt trigger in the state with Q10 conducting. Further assume that the base of Q10 is biased somewhere within the hysteresis band. Since Q10 is on, Q11 is off causing the collector of Q11 to be at 0V. This 0V output level, from the sweep control circuit, is coupled through R41, Elco pin A, and R13 to the gate of FET Q1 on the sweep amplifier board. This switches on Q1, thus shorting the integrating capacitor of integrator U1 causing the output of the integrator to be at 0V. This assures that the sweep generator is in a reset condition ready to generate a linear ramp on command from the sweep control circuit. Now consider a negative transition from the trigger generator, differentiated by C8 and applied as a negative spike to the base of Q10. Let the spike be sufficiently large in amplitude to drive the base of Q10 below the lower level of the hysteresis band. This turns off Q10 and turns on Q11. When Q11 conducts, its collector drops to roughly -4V which is coupled to the gate of FET switch Q1 on the sweep amp board. Q1 opens, releasing the integrator so the sweep starts to ramp positively from 0V. The sweep continues to ramp until it reaches a level sufficient to fire the hold-off monostable. When the hold-off monostable starts its timing interval, the collector of Q15 goes high causing the base of Q10 to be pulled high through CR10. The base of Q10 will be held more positive than the upper level of the hysteresis band for the timing interval of the hold-off monostable. As the base of Q10 goes high, the collector of Q11 goes to 0V thus causing FET Q1 to turn on. This allows the integrator to reset and the sweep waveform falls to 0V. For as long as the timing interval of the hold-off monostable lasts, the base of Q10 will be held high. This ensures that no more trigger signals coupling through C8 will fire the sweep control Schmidt until the termination of the hold-off monostable timing interval. The hold-off time is chosen to allow the integrator adequate time to completely reset to 0V. Each hold-off timing capacitor is chosen commensurate with each integrating capacitor. Another block diagram element, the auto trigger oscillator, also interfaces with the sweep control circuitry.

4-13. AUTO TRIGGER OSCILLATOR

The auto trigger oscillator is located on the main board and consists of a unijunction transistor oscillator and associated circuitry. Unijunction transistor Q8 oscillates at a rate determined by R28 and one of the selectable capacitors, C11, C12 or C13. Positive going spikes at the b1 terminal of Q8 are amplified and inverted by Q9. This particular configuration provides for fast negative transitions at the collector of Q9 and slow positive transitions. The fast negative transitions are differentiated by C15 and applied to the base of Q10 in much the same way as are ordinary trigger pulses. In the absence of ordinary trigger pulses the auto trigger oscillator provides substitute trigger pulses in order to achieve a trace. The most common use for this trigger mode is to achieve a reference line in the absence of an input signal. The auto trigger oscillator can be disabled from the front panel by switch S401, a push-pull switch concentric with the trigger level control.

When the knob is pulled S401 closes and the emitter of the unijunction is held at -8V, thus preventing it from oscillating. When the auto trigger oscillator is functioning and when ordinary trigger pulses are being generated the operation is slightly different. Consider an ordinary trigger pulse coupling through C8 to start a sweep. While the sweep signal is ramping, the output of the sweep control circuit, the collector of Q11, is at approximately -4V. This -4V level is coupled through R24 to the base of Q6. This causes Q6 to conduct, which causes Q7 to conduct, thereby clamping the emitter of the unijunction transistor to -8V. At the end of the sweep, Q6 is turned off when the output of the sweep control circuitry returns to 0V. Thus the auto oscillator is released at the beginning of hold-off time. After the hold-off interval, the sweep control circuit is ready to accept the next trigger pulse. If the input frequency is sufficiently high, the next trigger pulse will come from the trigger generator. If not, the auto trigger oscillator will issue the next trigger pulse to the sweep control circuitry. Generally the normal trigger mode is used for low frequency signals or for low duty cycle applications. The last block diagram element associated with the sweep timing is the blanking generator.

4-14. BLANKING GENERATOR

The purpose of the blanking generator is to synchronize the switching of the electron beam to the sweep signal. Thus the blanking generator is driven by the same logic signal as is the sweep generator. Emitter follower Q12 unloads the output of the sweep control circuit and provides a low driving point impedance for the blanking generator. The blanking generator, located on the main board, consists of transistors Q84-Q92, optical coupler U6 and associated circuitry. The buffered signal from the sweep control circuit is coupled to the base of Q84 through R244 and C108. Q84 logically inverts the drive signal and provides an 8V swing at its collector. The collector of Q84 couples through R247 and C109 to the base of Q85, whose collector provides the logical complement of Q84's collector. The two out-of-phase collector signals are coupled through C111 and C112 to the bases of Q88 and Q86, respectively. Transistors Q86, Q88, Q89 and Q90 comprise a four transistor flip-flop. The complementary configuration is used to achieve fast transition times in both the positive and negative direction. The power supply for the four transistor flip-flop is varied from approximately 7V to 45V by the intensity control, R272, in conjunction with the emitter follower decoupler, Q91. The negative side of this power supply is referenced 75V more negative than the CRT cathode potential. The outputs of the four transistor flip-flop switch from the -75V to the more positive point determined by the intensity control. The 75V is great enough to ensure that the tube will be completely cut off. The output from the Q88-Q90 side of the flip-flop is coupled through R266 directly to the blanking grid of the tube. The operation of the blanking generator, in relation to the sweep signal, can be traced starting with the output of the sweep control circuit. Consider the situation just as the sweep is triggered. The output of the sweep control circuit, the collector of Q11, goes from 0V down to about -4V. Emitter follower Q12 couples this negative transition through R244 to the base of Q84. Speed up capacitor C108 ensures the maintenance of fast transitions. Q84 saturates and its collector switches from roughly -8V to 0V. The positive transition at the collector of Q84 turns off Q85 through R247 and C109.

Thus the collector of Q85 makes a negative transition from 0V to roughly -8V. The positive transition at the collector of Q84 and the negative transition at the collector of Q85 are differentiated by C112 and C11 and are introduced at the bases of Q86 and Q88, respectively. This causes Q86 to turn on and Q88 to turn off. The cross coupling in the four transistor flip-flop also causes Q90 to turn on and Q89 to turn off. Thus the junction point of the collectors of Q88 and Q90 switches to the positive side of the variable supply. This positive level couples through R266 to the blanking grid of the CRT causing the electron beam to be turned on. When the sweep terminates the output of the sweep control circuit returns to 0V causing all of the described transitions to reverse themselves. This action eventually results in the junction of the collectors of Q88 and Q90 to go to the negative terminal on the variable supply which is referenced 75V more negative than the cathode potential, thus causing the electron beam to be blanked. This concludes the discussion on the conditioning and generation of the horizontal timing signals.

4-15. EXTERNAL X AXIS INPUT (X-Y Operation)

The Model PS915 also features X axis input capability. The external X axis signal is DC coupled and the frequency response of the horizontal channel extends to beyond 50KHz. The two counterclockwise positions of the sweep selector switch, S1, provide calibrated X axis sensitivities of .1V/division and 1V/division. The sweep vernier control also doubles as a 10:1 gain vernier for X axis inputs. There are two requirements to be met for X-Y operation:

1. Certain parts of the horizontal timing circuitry must be disabled.

2. The proper scaling for the input signal must be achieved.

4-16. X AXIS CONDITIONING LOGIC

When the Model PS915 is used with an external axis input it is necessary to disable the circuitry associated with sweep generation and control. This is done to prevent the injection of spurious noise onto the desired signal. The control function necessary to accomplish this disabling is located on the sweep amp board. If the sweep selector switch is set to any of the six sweep ranges, line G on the sweep amp board is left open. In this case the divider formed by R1 and R2 on the main board establishes line G at about +5V. This reverse biases diodes CR5, CR8, CR9 and CR11. However, if the sweep selector switch is in either of the two counterclockwise positions line G is pulled to -8V by b deck of the rotary switch. The -8V level couples through diode CR5 to the arm of the trigger level control, R402. This radically unbalances the input to the trigger generator so that it cannot issue any trigger pulses. The -8V level coupling through diode CR8 causes Q6 and Q7 to conduct, thereby disabling the auto trigger oscillator. The anode of CR8 also pulls down the collector of Q11 through R41. This ensures that the output of the sweep control circuit is completely disabled. The output of the sweep control circuit also couples through Elco pin A to the gate of Q1 located on the sweep amp board. It will become clear later why it is necessary to open FET switch Q1. The -8V level also couples through CR11 and essentially causes R44 to be put in parallel with R46.

This approximately doubles the divider ratio to the input of the hold-off monostable. This is done to prevent the hold-off monostable from firing in the presence of large horizontal input signals. The last logic diode, CR9, couples the -8V level to the cathode of the light emitting diode in U6, the optical coupler. This lights the LED which turns on the photo transistor, also contained with the optical coupler, U6. The photo transistor turning on causes Q87 and Q92 to turn on. Q87 clamps the base of Q88 to the negative side of the variable intensity supply and Q92 clamps the base of Q89 to the positive side of the variable intensity supply. This sets up the four transistor flip-flop so that the trace is unblanked, insuring that the beam is always on for X-Y operation.

4-17. X AXIS SIGNAL SCALING

The X axis signal scaling circuitry is located on the sweep amp board. It consists of two operational amplifiers and associated components. The first operational amplifier provides a 1 Megohm input impedance and operates at a gain of .1 or 1 depending upon which X-Y gain range is selected. The second operational amplifier serves to level shift the signal and incorporates a 10:1 gain vernier. The external X axis signal is applied at BNC J401 and is coupled through R401 to the sweep amp board. Assuming the sweep selector switch to be in one of the two X-Y gain ranges, the signal is routed through deck a of rotary switch S1, the sweep selector switch. From deck a the input is routed to R12, the input resistor of the first operational amplifier. Integrated Circuit U2 serves as the first operational amplifier and has two gains selectable by the f deck of switch S1. On the 1V/division range the feedback path is directly through R14 from the output of U2 to the summing junction, yielding a closed loop gain of -0.1. On the .1V/division range the output of U2 is fed through the resistive divider comprised of R15 and R16 and fedback through R14 to the summing junction giving a gain of -1.0. Integrated Circuit U1, which also serves as the sweep generator, provides the second operational amplifier. When either of the two X-Y gain positions is selected, resistor R11 is switched in as U1's feedback element instead of an integrating capacitor. The output of U2 is coupled through gain vernier rheostat R4 and fixed resistor R3 to the last two positions of d deck of the sweep selector switch S1. The wiper of d deck couples directly to the summing junction of U1. When the gain vernier control is turned fully clockwise, R4 is shorted out yielding a net gain through U1 of -8.43. When the gain vernier control is turned fully counterclockwise it yields a gain reduction factor greater than 10. R1 and R2 introduce a negative bias current into the summing junction of U1, thus setting the output of U1 at approximately 4.2V quiescently. The output of U1, whether used as a sweep generator or an X amplifier, is coupled through Elco pin B to the horizontal output amplifier located on the main board.

4-18. HORIZONTAL OUTPUT AMPLIFIER

The horizontal output amplifier is in many respects quite similar to the vertical output amplifier. It is a single-ended-in-to-differential-out gain stage that drives the horizontal deflection plates. Gain stability is achieved using local feedback and push-pull outputs provide low distortion at high frequencies. The X5 horizontal scale expander is also located in the horizontal output stage.

Transistors Q34 and Q35 comprise a differential amplifier stage with their emitters coupling through R97 and R98 respectively to current source Q37. Potentiometer R95 and fixed resistor R96 provide the horizontal calibration adjustment. The signal applied at the base of Q34 is converted by the differential action of the stage into a difference current signal at the collectors of Q34 and Q35. This differential current signal is applied to complementary common base stages, Q22 and Q28 on one side, and Q27 and Q33 on the other side. The common base outputs are coupled to emitter follower transistors Q23, Q29, Q26 and Q32. The emitter followers drive through biasing diodes CR17, CR25, CR19 and CR27 to the bases of complementary common emitter push-pull output stages comprised of Q24 and Q30 on one side and Q25 and Q31 on the other side. Local feedback is employed from X1 and X2 through resistors R73 and R68, respectively to the inputs of the complementary common base stages. This output amplifier provides a differential voltage swing greater than 200V which is necessary to drive the horizontal deflection plates. Diodes CR18, CR24, CR20 and CR26 are used to prevent the output stages from saturating, thus providing for fast recovery from overload. R100 in the emitter circuit of Q37 varies the current through Q37 to bias output X1 and X2 symmetrically about 0V. Horizontal positioning is introduced through emitter follower Q36 to the base of Q35. Potentiometer R403, the horizontal positioning control, varies the voltage on the base of Q36 which in turn varies the voltage on the base of Q35, thus unbalancing outputs X1 and X2. Scale expander switch S402, which is concentric with positioning control R403, increases the gain of the horizontal output stage by a factor of five when pulled. This is accomplished by dropping the emitter resistance in the emitters of Q34 and Q35. R93 is provided to adjust the gain when in the X5 position.

4-19. POWER SUPPLY

The major elements of the power supply consist of the step-down power transformer, rectifier-filter circuitry, a DC regulator, battery charger, and inverter circuitry. The input voltage to the inverter is regulated rather than employing six individual regulators on the outputs.

A three prong power cord is connected to J501, the connector portion of the voltage selector and fused connector module. This grounds the chassis of the instrument to earth ground if a 3 wire AC outlet is used. For floating operation it is recommended to disconnect the AC line cord and use batteries for the power source. The AC power is coupled through fuse F501 and switch S502 to the voltage selector, S501, in the voltage selector and fused connector module. The proper primary taps of the power transformer are selected by S501 in accordance with local line voltage. Power transformer T501 has two secondaries, the main power winding and the battery charger winding.

The output of the main power winding is rectified by CR40 and CR41 and filtered by capacitors C88-C91. The output voltage at nominal line is approximately 16vdc. The DC regulator consisting of Q501, Q71, Q72, U5, CR49 and associated circuitry supplies a regulated, low ripple 10vdc output to the inverter. Potentiometer R213 is adjusted to set -8.1vdc at test point TP4.

The inverter circuitry consists of transformers T1, T2, T3, transistors Q73, Q74 and associated circuitry. T1 is a flux switching transformer that supplies base drive to power transistors Q73 and Q74.

Q73 and Q74 alternately switch each half-primary of T2, the intermediate inverter transformer. Five secondaries of T2 are rectified and filtered to provide DC power supplies of +5v, ±8v, ±12v, ±25v and ±65v. The +5v and ±12v supplies are used primarily by the Model 975 and are coupled to the 975 by connector J5. Another secondary of T2 is used to drive high voltage transformer, T3.

The high voltage transformer, T3, supplies -1750vdc for the CRT cathode potential, 6.3v rms for the CRT heater power and 45vdc for the blanking supply. A "bootstrap" regulator is employed for the high voltage to provide load regulation as the CRT beam current is varied by the intensity control. The high voltage regulator consists of Q82, Q83 and associated circuitry configured as an operational regulator. The +65vdc supply serves as the reference and feedback is taken through the focus string of resistors R253, R271, R252, and R251. R250 is varied to establish the output dynamic range of the regulator at TP5 commensurate with the load regulation requirements of the -1750vdc supply.

4-20. BATTERY CHARGER

The battery charger for the PS915 derives its power from a separate winding of the power transformer, T501, and consists of Q75, U7 and associated components. CR57 serves as a reference for the feedback stabilized battery charger. When the battery terminal voltage is below the "taper" level established by the feedback divider, R223, R224, and R225, the output of U7 turns on Q75 which goes into a current limited mode to charge the battery from a constant current source. When the battery charges to the "taper" level established by the feedback divider, the charger reverts to a constant voltage mode and only supplies the current demanded by the battery. When the instrument is battery operated, the current from the battery is coupled through rectifier CR42 to the regulator input. When line operated, CR42 is reverse-biased. The batteries are located on the instrument bottom cover and are coupled through J6 and J7 to the charger circuit. Fuse F1 and CR54 provide protection against battery reversal.

4-21. PROBE COMPENSATOR

A square wave for probe compensation is provided at the front panel of the PS915. The square wave generating circuitry consists of transistors Q78-Q80, unijunction transistor Q81, and associated components. The unijunction oscillator frequency is adjusted by R237. The oscillator triggers the flip-flop composed of Q79 and Q80 through capacitors C102 and C103. The flip-flop frequency divides by two and yields a square wave output. Q78 buffers the flip-flop output and provides a means of adjusting amplitude with R227. Q78's collector signal is coupled by shielded cable to J403 on the front panel.

THEORY OF OPERATION MODEL 975

4-22. The Model 975 DMM/Counter consists of a 3 1/4 digit, three function digital multimeter and a four digit, 20 MHz frequency counter. The DMM section of the instrument has two separate inputs. The first, located on the front panel of the 975, features 10 MΩ input resistance on DC and AC and is also used for KΩ. The second input mode places the DMM in parallel with the scope input behind the scope input coupling. The input to the counter comes from the scope trigger generator. Refer to block diagram, Figure 4-3 and schematic diagram 9751001.

4-23. DMM FUNCTION SELECTION AND CONTROL

Four station, interlocking push button switch S2 controls the routing of input signals to the DMM and also provides logic signals for function selection. Each switch station consists of a four-pole, double throw switch. The discussion will treat each of four situations;

1. "SCOPE" Depressed
2. "DCV" Depressed
3. "ACV" Depressed
4. "KΩ" Depressed

4-24. "SCOPE" Button Depressed

With the SCOPE button depressed the DMM receives its input from the oscilloscope. The signal line to the DMM (a shielded cable) is coupled through the oscilloscope's input coupling. So, if the operator depresses the "AC" coupling button on the oscilloscope, the signal is AC coupled to both the oscilloscope and the DMM. Similarly, if the "DC" button on the scope is depressed, the signal is direct coupled to both instruments. Additionally when the DMM is in SCOPE mode, the oscilloscope coupling switch controls lines which program AC or DC function to the DMM. These logic lines are coupled from connector P5 to the SCOPE station of switch S2. With the SCOPE button depressed the logic signals are routed to FET switches, Q26 and Q27, which control the input to the analog processor.

4-25. "DCV" Button Depressed

With DCV depressed the DMM accepts its input from connector J301, the input connector located on the DMM front panel. Since the SCOPE button is extended, the logic lines from the oscilloscope are opened and FET switch Q27 is closed by programming from the DCV station. The shielded wire from the oscilloscope is also switched to a dummy resistor-capacitor network, R75 and C52, which simulates the impedance of the DMM input as seen by the oscilloscope. The input signal is coupled from the "AUX" input on the front panel via shielded cable through the DCV station to R76, the input resistor to the Input Buffer.

4-26. "ACV" Button Depressed

The ACV operational mode of the DMM allows the instrument to measure the RMS value of a sinusoidal input waveform. ACV mode is very similar to DCV in terms of the switching performed by S2. When the ACV button is depressed, the input signal is coupled from J301 through capacitor C16 and the ACV station of S2 to the input buffer. C16, the input coupling capacitor, blocks any DC component of the input signal so that only the AC is passed into the input buffer.

NOTE

When the DMM is operated in SCOPE mode and when AC coupling is selected on the oscilloscope, the input coupling capacitor is provided by the scope.

The ACV station of S2 also closes FET switch Q26 to select the output of the AC convertor.

4-27. "KΩ" Button Depressed

When the DMM is operated in the KΩ mode, the input is taken from the AUX input only. KΩ cannot be programmed from the oscilloscope. When the KΩ button is depressed, the ohms convertor is switched across the AUX terminals by the KΩ station. The polarity LED, DS2, is also disconnected by the KΩ station so that a negative indication cannot be given.

4-28. INPUT BUFFER

The Input Buffer performs all necessary scaling for input signals when the DMM is operated in ACV, DCV, or SCOPE. It is configured as an operational amplifier having a fixed input resistor and switched feedback resistors to provide ranging. There are four ranges corresponding to gains of -1, -.1, -.01, and -.001.

The output of the function control switch is routed to input resistor R76 which couples to the summing junction of the input buffer. Dual FET U28 and integrated circuit U29 comprise the active portion of the input buffer. U28 is employed to give high input impedance and is operated as a dual source follower with the non-signal input used to zero the amplifier output. The output of the signal-side FET couples to the inverting input of U29 yielding an inversion from input to output. The output of U29 is coupled back to the summing junction through R87. The output also goes to three other feedback networks which are switched by FET switches Q21-Q24. Each network consists of a fixed resistor in series with a reostat used for alignment. FET switch Q21 is provided for additional isolation when operating on the 2V range. Without Q21 there is to much parasitic feedback capacitance at 5 KHz. Range information is decoded by the auto range control circuitry, level shifted by the range drivers, and applied to the proper gates of Q21-Q22. To select the 20V range Q21 and Q22 are turned on. Similarly, Q23 and Q21 turned on selects the 200V range and Q24 and Q21 select the 2000V range. The input buffer is designed such that it provides ranging for both AC and DC signals.

4-29. AC CONVERTOR

The Output of the Input Buffer also is coupled to the AC Convertor consisting of U9, U12 and associated circuitry. U9 is configured as precision rectifier so that the signal at the junction of CR15 and R99 is a positive-going, half-wave rectified sine wave. This signal is summed with the input signal through weighted resistors R102 and R101 to the summing junction of operational adder U12. The weighted summing yields a full-wave rectified current into the summing junction of U12. R106 in series with R108 sets the gain of the adder so that the average DC value at the output of the adder can be adjusted to the RMS value of the input signal. C29 serves to filter the rectified signal. R95 is provided to adjust U9's offset to zero and R103 adjusts U12's offset to zero.

4-30. OVERLOAD LIMITING AND OUTPUT SWITCHING

The output of the Input Buffer and the AC Convertor are switched by FET switches Q27 and Q26, respectively, to the input of the Analog Processor. The Function Selector switch, S2, controls the switching state of Q27 and Q26. In order to ensure that Q27 and Q26 can be turned off by their drive circuits, overload limiting is employed at the output of the Input Buffer and AC Convertor. Q28 and Q37 biased as emitter followers by resistive dividers provide clip levels for diodes CR20, CR26, and CR21. All the FET switches employed in the DMM operate essentially the same way. Thus, the following discussion of Q27 will virtually apply to all others. If point "J" on the schematic is left open, the cathode of CR22 will tend to drop to -12V due to R115. This will forward bias CR22, pulling down the gate of Q27. Assuming the source of Q27 to be at a relatively low impedance point that stays near 0V, the gate will go almost to the negative supply (R114 and R115 form a voltage divider, neglecting CR22). With the gate almost 12 volts below the source, the drain-source path becomes a very high resistance. If point "J" is switched to +12V, CR22 is reverse-biased, very little current flows through R114, and the gate-source potential is nearly zero. This causes the source-drain path to go to a low resistance, turning Q27 on.

4-31. REFERENCE

The reference for the Model 975 provides a stable voltage for the Analog Processor and the Ohms Convertor. The low impedance, stable voltage is achieved by reference element CR9, Integrated Circuit U25, and associated circuitry. Current flows from the output of U25 through CR9 and R54 to circuit common. The voltage drop across R54 is applied to the non-inverting input of U25. The output of U25 drives positive as does the divided point of the resistive divider comprised of R56, R57 and R58. This divided voltage is fed back to the inverting input of U25. The output of U25 assumes a voltage such that both inputs to U25 are nearly equal. R57 is adjusted until the voltage across R54 is commensurate with the recommended current for CR9. Thus, the reference voltage is the sum of the reference element drop and the drop across R54.

4-32. OHMS CONVERTOR

The measurement of resistance with the Model 975 utilizes a precision current source to pass a known current through the unknown resistance. The resulting voltage drop is applied to the analog processor. The current source consists of integrated circuits U26 and U27, FET Q17, FET switches Q18, Q19, and Q20, and associated circuitry. The reference voltage is divided by resistive divider R59, R60, and R61. The divided point is applied to one input of dual FET U26, operated as a dual source follower. The outputs of U26 couple to the inputs of U27. The output of U27 drives the gate of FET Q17, operated as a source follower with respect to the feedback path. The voltage on the source of Q17 is fed back to the other input of U26. Consider FET switches Q18-Q20 open for the following discussion. Q17 draws current through R64 until the voltage drop across R64 equals the drop across the top part of the resistive divider. R60 is adjusted until the current through R64 is 1 μA. Since the source current and drain are almost equal in a low leakage FET, the drain current is 1 μA for all practical purposes. The drain of Q17 couples through protection thermistor R74 and the KΩ station of the function selector switch to the front panel connector J301. The voltage thus derived at J301 is coupled back through the KΩ station to the input of the analog processor. FET switches Q18-Q20 are alternately closed to switch in other resistors to obtain different constant currents, thus providing additional KΩ ranges.

4-33. RANGE DRIVERS

The Model 975 is fully auto-ranging on DCV, ACV, and KΩ . Range information is provided by the digital processor to the range control circuitry. The range control circuit provides logic signals to the range drivers for selecting the proper range of the input buffer or the KΩ Convertor. Each range driver consists of level shifting circuitry to drive FET switches. The following discussion treats the operation of one range driver. The other three function quite similarly. Consider pin 15 of U17 to be at 0V. The 0V level couples through R127 to the emitter of common base stage Q34 causing it to be turned off. With Q34 non-conducting no current flows into the base of Q33. Thus, Q33's collector passes no current and sets at the reference voltage provided through R70. This causes Q19 to be switched on since its gate and source are at the same potential. So, if KΩ has been selected, the 20 KΩ range is chosen and the precision current source outputs 100 μA. With the collector of Q33 at the reference potential CR23 is reverse-biased causing the gate of Q22 to be at 0V. Since the source of Q22 is also at 0V, the 20V range of the Input Buffer is selected. If the logic level at pin 15 of U17 is at +5V, the above reasoning complements, resulting in the gates of Q19 and Q22 to be at -12V causing them to be switched off.

NOTE

The "2" range output (collector of Q35) is logically inverted by Q25 resulting in Q21 being turned on for all ranges except the "2" range.

4-34. ANALOG PROCESSOR AND DIGITAL PROCESSOR

The Analog and Digital Processors are MOS integrated circuits that convert a DC input to four-digits of BCD information. The Analog Processor contains an input buffer, an integrator, and other circuitry. The conversion technique consists of a variation of a pulse-rebalance scheme in which the number of rebalance pulses are counted over an accurate time interval. The counting and accumulation of the pulses is done by the digital processor. The digital processor also puts out four-digits of BCD data which is multiplexed. The clock which feeds the digital processor is derived from the crystal oscillator. The clock frequency is chosen to achieve maximum noise rejection at multiples of 60 Hz. C33 also provides filtering for additional noise rejection.

4-35. BCD - SEVEN-SEGMENT DECODER

The BCD output lines from the digital processor couple directly to U20, a BCD-seven-segment decoder. The decoder's seven outputs feed the readout integrated circuit through current setting resistors.

4-36. READOUT AND DECIMAL POINT LOGIC

The integrated circuit, LED readout, DS3, accepts decoded data from U20 and the multiplex lines from the digital processor integrated circuit, U21. The digit strobes from U21 are logically inverted by four of the inverter gates of U15 and drive into DS3 through diodes CR32-CR35. When one of the digit strobes goes high, the corresponding multiplex line into DS3 pulls down. This enables one digit's-worth of LED segments since the cathodes of any digit's segments are tied in common. The decoded outputs of U20 light the proper segments through R150-R156. The inverted digit strobes are "nored" with information from the auto range control circuitry to obtain decimal point information. When one of the "nors" of U13 has both inputs low, it turns on one of four transistors, Q40-Q43. The collectors of Q40-Q43 are all "wire-ored" and turn on Q39 to light a decimal point through R162.

4-37. AUTO RANGE CONTROL

The Auto Range Control Logic consists of shift register U17, monostable U19, and associated circuitry. The discussion of the operation can be best understood by assuming a downrange condition and an uprange condition.

4-38. DOWNRANGE CONDITION

The Digital Processor indicates a downrange condition (less than 0100) by pulling the most significant data bit high at the time the most significant digit strobe comes high. These logical outputs are inverted and "nored" by one of the gates of U18. The "nor" output feeds the preset inputs of shift register, U17, to set all U17's outputs high. This corresponds to the lowest range of the DMM. Thus, the auto range circuitry always causes the DMM to step to its lowest range upon receipt of a downrange command. The outputs of the shift register feed directly to the range drivers.

4-39. UPRANGE CONDITION

Consider that the shift register is left in a downrange condition. This implies that outputs A, B, and C are high. The Digital Processor indicates an uprange condition by pulling all digit strobes alternately high and low. The inverted strobe lines feed a four-input "nand" whose output couples to monostable U19. When the input of U19 is pulled low, its output goes high and stays high for a time determined by R160 and C42. The input to U19 can be pulsed without affecting the output until the timing cycle is completed. The positive transition out of U19 clocks U17, causing a low state to be shifted into the first bit of the shift register. This leaves all but the A output high, corresponding to the 20's range. In the event of further uprange commands a high level is shifted into the shift register. The delay is provided to assure adequate conversion time for the processors so that false upranging doesn't occur. When the highest range is chosen, the C output is fed to the reset line of U19 to prevent further bit shifting.

4-40. COUNTER OPERATION

The counter for the Model 975 derives its input from the oscilloscope trigger circuit. A crystal oscillator provides an accurate time gate over which the counter accumulates scope trigger pulses. All accumulating, decoding, and latching is done by a single chip, four-digit counter. Range selection and decimal point control is performed by a five-station, push button switch.

4-41. RANGE SELECTOR AND INPUT FREQUENCY DIVISION

The level-shifted trigger signal from the oscilloscope is coupled to the 975 via shielded cable. This input signal goes to the Range Selector switch, S1, a five-station, interlocking push button switch. The input is also routed to a three-decade frequency divider consisting of U1, U2, and U3 with outputs from the decade points coupled to the Range Selector switch. Decimal point control is also provided by the Range Selector switch. The following table shows the relationship between the selected range, the gate time, and the factor by which the input frequency is divided.

RANGE	GATE TIME	INPUT FREQUENCY DIVISION
10 KHz	1 second	none
100 KHz	.1 second	none
1000 KHz	.1 second	10
10 MHz	.1 second	100
20 MHz	.1 second	1000

Table 4-1. Range Selector and Input Frequency Division

4-42. CRYSTAL OSCILLATOR AND TIMING CIRCUITRY

The crystal oscillator consists of a differential amplifier stage, Q1 and Q2, with the crystal used as an element to introduce positive feedback. Q3 and Q4 serve as level shifters to "square-up" the oscillator output. The 3.2768 MHz output is applied to U23 which divides the frequency by four to yield 819.2 KHz. The output of U23 is further divided by 16,384 in U24, a 14 bit binary counter, to achieve 50 Hz at the bit 14 output. The output from bit 1, 409.6 KHz, is divided by 10 to achieve a 40.96 KHz clock for the DMM, a frequency chosen to maximize 60 Hz noise rejection. The bit 14 output is also further divided by 10 in U8 to obtain 5 Hz necessary for the one-second gate interval. The 50 Hz and 5 Hz outputs are coupled to the range selector switch so that the proper gate time can be selected.

4-43. GATE GENERATION AND HOUSEKEEPING

The 50 Hz or 5 Hz signal couples from the range selector switch to decade counter U7, which further divides the signal to 5 Hz or .5 Hz, respectively. The "low" half-period becomes the .1 sec or 1 sec gate which "nors" with the input frequency in U5 to create the input signal to the counter, U10. Other outputs from U7 are gated in such a way as to create two "housekeeping" signals for U10. The first housekeeping pulse, named $\overline{XFR}$, transfers the count to the output latches for presentation to the BCD-Seven-Segment Decoder, U11. The other pulse, $\overline{RST}$, resets the counter to zero. Both pulses occur during the "high" half-period after the gate is removed.

4-44. FOUR-DIGIT COUNTER

U10, the four-digit counter, can achieve a count of 9999 and has all necessary logic for multiplexing the four digits. The output is BCD formatted and is inverted before feeding to the BCD-Seven-Segment Decoder. A count extend output is provided to activate the Over-Range Flasher circuit in the event of an over-range. (A second over-range condition detector is provided and will be discussed later.)

4-45. BCD-SEVEN-SEGMENT DECODER AND READOUT

The BCD output lines from the four-digit counter couple to inverter transistors, Q12-Q15, the collectors of which feed U11, a BCD-Seven-Segment Decoder. The decoder's seven outputs feed the readout through current setting resistors, R43-R49. The LED readout, DS1, accepts decoded data from U11 and the multiplex lines from the four-digit counter. The digit strobes are logically inverted by Q8-Q11 and drive into DS1 through diodes, CR5-CR8. When one of the digit strobes goes high, the corresponding multiplex line into DS1 pulls down, enabling one digit's-worth of LED segments. U11's decoded outputs light the proper segments through R43-R49. Decimal point information is switched by S1 from the inverted digit strobes to Q16 which feeds DS1.

4-46. OVER-RANGE FLASHER

The counter readout blinks when an over-range signal is processed by the four-digit counter. This is accomplished by setting two transistor latch, Q6 and Q7, with the count extend output from U10. When the latch is set, it drives the lamp test terminal of U11 to blank the readout. The reset pulse to U10 also resets the latch to unblank the readout. Since the set and reset signals are at a 10 Hz or 1 Hz rate, the readout will blink. An alternate way of creating a blinking readout is also included. If the input frequency is too high for the four-digit counter to process (a situation created by inputting a very high frequency when the counter is locked on a low range), no count extend is issued. To cover this situation, a two-bit counter, U4, is employed. A 9.76 μsec gate from the bit four output of U8 is used to detect frequencies above 100 KHz. When the two-bit counter finds a frequency above 100 KHz, it sets the flash latch instead of the count extend from U10. The latch is reset the normal way.

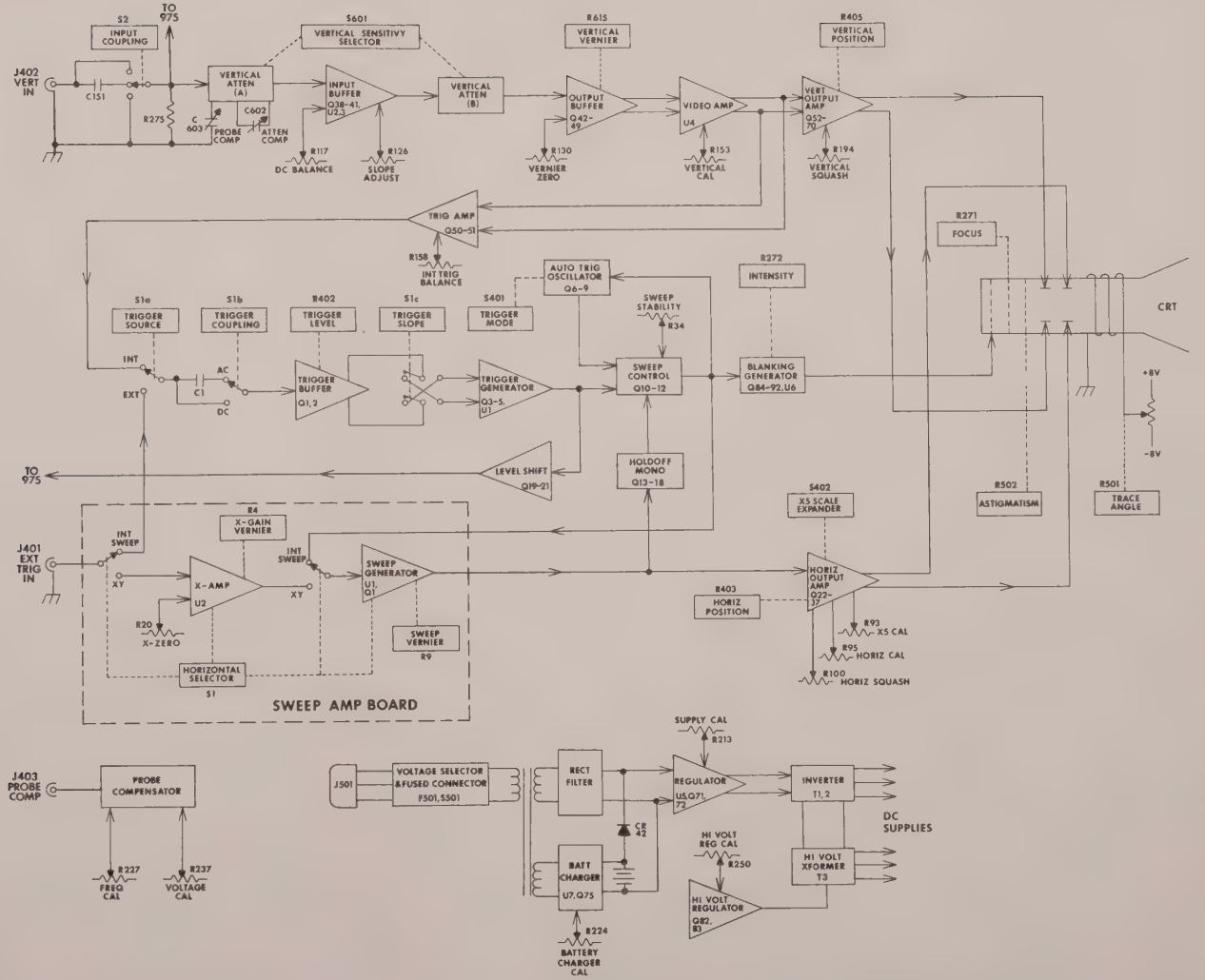


Figure 4-2. Block Diagram PS915

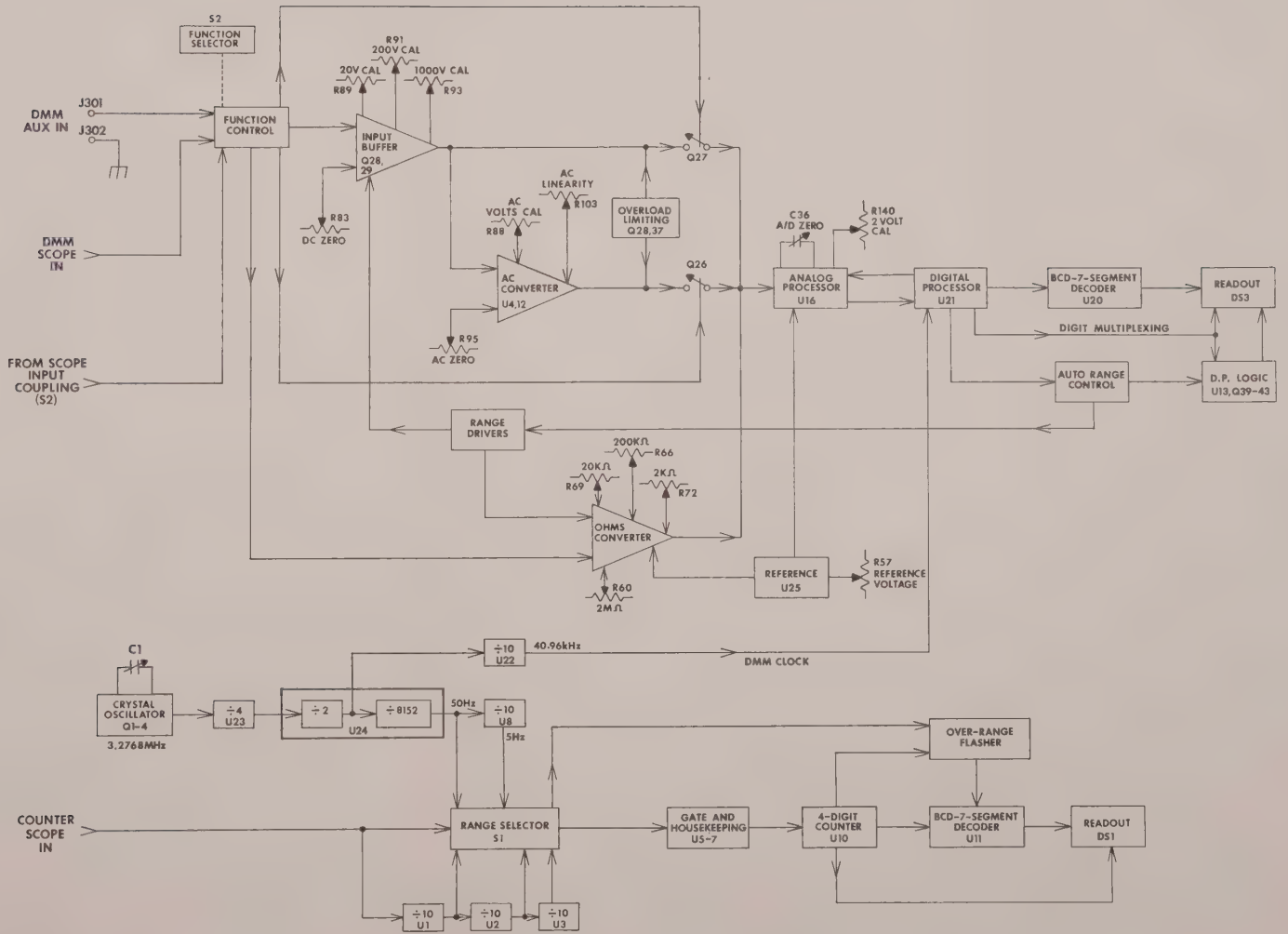


Figure 4-3. Block Diagram Model 975

SECTION V

MAINTENANCE

5-1. GENERAL

This section contains information for preventive maintenance, troubleshooting, corrective maintenance and calibration for the PS915 Oscilloscope and the Model 975 DMM/Counter.

5-2. PREVENTIVE MAINTENANCE

Preventive maintenance consists of periodic cleaning, inspection, tightening and recalibration of the oscilloscope and DMM/Counter. It should be performed on a regular basis to keep the instrument in its best operational and appearance condition.

5-3. Cleaning

Accumulation of dirt, dust and grime should be removed whenever they become noticeable. The frequency of cleaning is largely dependent upon the environment in which the instrument is used. Dirt on the outside covers may be removed with a soft cloth moistened with a diluted household cleaning solution.

CAUTION

Do not use solvents which may attack the painted or plastic parts of the instrument. Chemicals such as MEK, Laquer thinner, or strong acids or alkali may cause paint removal, shorted switches, circuits, etc. and melting of plastic parts.

Fingerprints on the cathode ray tube (CRT) faceplate should be removed with lens cleaning tissue. Dust accumulation inside the instrument may be blown out with low pressure air.

CAUTION

Whenever the covers are removed from the instrument, make sure that the instrument is disconnected from the AC power line and the battery pack is removed. The interior of the instrument contains high voltage circuits which could be hazardous to your health if the instrument power switch was accidently turned on during maintenance, with a power source connected.

5-4. Inspection

After cleaning the instrument, visually inspect the components on the printed circuit boards. Look for components such as resistors which may have become discolored from overheating and for wires having frayed insulation from vibration. A close visual inspection can many times uncover the source of future problems. Removal of the printed circuit boards is not recommended unless a part replacement is indicated.

5-5. Tightening

Front panel knobs and any screws which might have worked loose should be tightened. The black vertical attenuator knob and the black time-per-division knob may be tightened by first removing the red vernier knobs (the screw is located under the red knob cap). Using a one quarter inch deep socket, tighten the black knobs. The other knobs are tightened with a small screwdriver. A drop of rubber cement is helpful in retaining the plastic knob caps.

After many insertions and removals, the printed circuit board pins have a tendency to spread. These may be tightened by removing the board and squeezing the pins with needlenose pliers. Care in removal will prevent pin spreading.

5-6. Recalibration

Recalibration of the instrument at regular intervals will assure that measurements made will be within the accuracy specification. It is recommended that the instrument be recalibrated after 1000 hours of operation, or twice a year. The calibration procedures are provided in the latter part of this section of the manual. If electronic parts, such as resistors and integrated circuits have been replaced during the preventive maintenance procedure, recalibration should be performed to return the instrument to specification.

5-7. TROUBLESHOOTING

Most of the problems resulting in a malfunction will be a defective component or a mechanical defect. Verify that the problem is not due to an incorrect switch position (refer to section III for control functions). The CRT display can be a valuable aid in pinpointing the area of many problems. The loss of any of the amplifiers, (Vertical or Horizontal) trigger circuit (Internal or External) or blanking circuit will be noticeable on the CRT.

Some problems may result severe loading on the power supplies and these problems will be more difficult to isolate. The power supply for the PS915 is comprised of a DC-to-DC inverter. The normal operating frequency of the inverter is approximately 16khz. Any malfunction that places a heavier than normal load on the power supplies will cause this frequency to shift. The power ON light located on the front panel is a quick check for inverter operation.

The current limiting resistor (R206) in the -10 volt regulator also makes for a quick check for proper operation. The normal operating current for the PS915 is approximately one ampere and an additional 400 ma. for the Model 975.

The DC-to-DC inverter can be disconnected from the -10 volt regulator in the event of a suspected malfunction. If the jumper is removed, a 100 ohm, one watt resistor must be placed across the regulator output for proper operation. Also keep in mind that the -10 volt regulator is not connected to the chassis ground and all voltage measurements are referenced to its own 0 volt buss.

The high voltage quadrupler can be disabled by lifting one end of resistor R270. Two more jumpers are available at the +8 volt and -8 volt outputs.

5-8. Troubleshooting Precautions

WARNING

Before removing the covers for trouble-shooting, read and observe the precautions given below. The instrument contains a CRT and potentially lethal high voltages, which may become hazardous if not handled properly.

1. Always remove the line cord and battery pack from the instrument before removing the covers.

2. Wear "safety" goggles with side shields when handling the CRT to prevent possible injury from flying glass in case of tube breakage. When removing the CRT from the tube shield, be very careful of the tube tip located in the center of the tube socket. Do not strike or scratch the CRT and never subject it to more than moderate pressure when installing in, or removing from the instrument.

3. When operating the instrument with power on, and the covers removed, avoid contact with the left, rear area of the PS915 master board. This area contains the high voltage quadrupler, blanking circuit and CRT intensity and focus controls. All of this area is operating at approximately -1700 volts.

4. Avoid shorting the power supplies.

5. Do not unplug any board with power applied to the instrument.

6. With the battery pack attached to the instrument, do not consider the instrument to be "dead" when the line cord is disconnected.

5-9. PARTS IDENTIFICATION

The parts list is divided into 7 sub-sections for the PS915 and 2 sub-sections for the Model 975 DMM/Counter. These sections are:

a. Front Panel Sub-Assembly

b. Master Board Sub-Assembly

c. Vertical Switch Sub-Assembly

d. Sweep Amplifier Sub-Assembly

e. Rear Panel Sub-Assembly

f. Chassis Assembly

g. Final Assembly

h. DMM/Counter Sub-Assembly

i. DMM/Counter Chassis Sub-Assembly

Each part is identified by a drawing reference designator, manufacturer part number, description of part, manufacturer and Vu-Data part number. When ordering replacement parts from Vu-Data, be sure to include the Vu-Data part number for ease of identification.

5-10. Corrective Maintenance

Individual components are generally "off-the-shelf" and are available at local suppliers or may be ordered from Vu-Data. If other parts are substituted, make sure that the part is a direct replacement, or performance and calibration difficulties may result.

Refer to Fig. 5-3 and 5-4 for the location of test points, calibration controls and pin identification. A thorough understanding of the theory of operation section is a valuable aid in tracing signals through the various circuits.

5-11. MODEL PS915 CALIBRATION

The following procedure provides the information necessary for technical personnel to align and calibrate the Model PS915 Oscilloscope. The alignment should be accomplished at regular periodic intervals to insure the proper operation of the instrument. Since the power supplies affect the calibration of the other circuits, they should be calibrated prior to the other sections.

The calibration procedure is divided into two parts, one for the Model PS915 Oscilloscope and one for the Model 975 DMM/Counter.

WARNING

When performing instrument calibration, the top cover must be removed. High voltages, which could be lethal, are accessible and extreme caution should be taken. Screwdrivers with insulated shafts should be used for setting the adjustments. The power should be off, and the line cord disconnected, while the cover is being removed or installed.

5-12. Test Equipment Required

The following test equipment is required to calibrate the instrument. The model number and manufacturer of the equipment may be substituted provided the specification of the substituted unit is equal to, or better than the listed equipment.

1. Function Generator - H-P Model 3310A
2. Frequency Counter - H-P Model 5325A
3. Digital Voltmeter - Data Tech Model 30
4. Constant Amplitude Generator - Tek Model 191
5. Oscilloscope - Tek 7600

NOTE

When calibrating a Model PS915 with a Model 975 DMM/Counter, the Model 975 should not be used as the calibrating instrument. The two units share a common power supply and adjustment of the power supply may affect the calibration accuracy of the Model 975 DMM/Counter.

5-13. Location of Controls for Alignment

Figure 5-1 shows the location of the front panel controls. Fig. 5-2 shows the control locations on the rear panel. Fig. 5-3 shows the location of the calibration controls, test point locations and pin identifications for the PS915 Oscilloscope. Fig. 5-4 shows the location of calibration controls and test point locations for Model 975.

5-14. Preliminary Control Settings

Remove the battery pack and AC line cord. Remove the top cover of the oscilloscope. Plug in the line cord and turn the instrument on, allow a ten minute warm-up period before starting the calibration procedure.

Set the front panel controls as follows:

1.	Input coupling switch	DC
2.	Vertical attenuator switch	.5V/Div
3.	Vertical vernier control	Calibrate
4.	Vertical positioning	Centered
5.	Intensity	Centered
6.	Focus	Centered
7.	Trigger source	Internal
8.	Trigger coupling	DC(Direct)
9.	Trigger polarity	+(Positive)
10.	Trigger mode	Auto
11.	Time/Div switch	10ms/Div
12.	Horizontal vernier	Calibrate
13.	Horizontal positioning	Centered

5-15. POWER SUPPLY CALIBRATION

a. Turn the intensity control to full intensity. Apply a 100Hz square wave to the vertical input and set the amplitude of the generator for approximately a full scale display. Connect the digital voltmeter between TP (Common) and TP (-8V). Adjust the -10v regulator control in the power supply, R213, until the voltmeter reads -8.10vdc ± 0.05vdc.

b. Connect the high lead of the voltmeter to TP (Reg). Adjust the high voltage regulator control, R250, until the voltmeter reads -45vdc ± 2.0vdc. Slowly reduce the intensity control until the trace disappears. The voltmeter should read approximately -10vdc.

c. Connect the voltmeter to the battery terminal connectors (use CR54) located on the bottom cover. Adjust the battery charger control, R224, until the voltmeter reads 13.5vdc ± 0.05vdc. Disconnect the voltmeter leads.

5-16. Adjust the intensity control for a suitable intensity level. Depress the vertical input GND switch and place the Time/Div switch to the 1V/Div range. Adjust the focus and astigmatism controls for the best spot definition. Return the Time/Div switch to the 1ms/Div range. Adjust the trace angle control until the horizontal base line is parallel with the horizontal graticule lines.

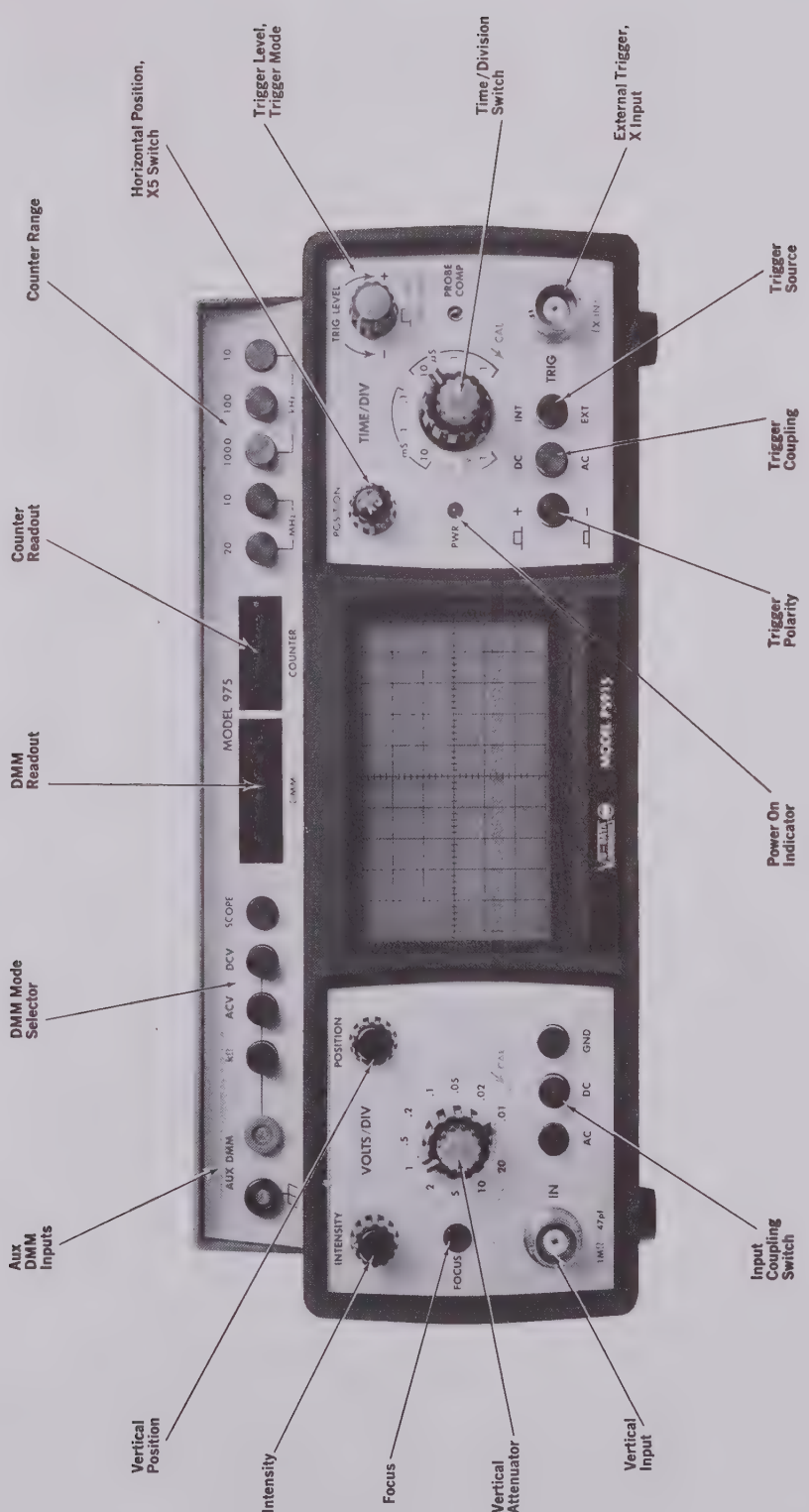


Figure 5-1 Location of Front Panel Operating Controls Model PS915/975

5-17. VERTICAL CALIBRATION

a. Depress the DC coupling switch on the vertical input coupling selector. Adjust the low frequency compensation control, R126, for the best square wave response on the CRT.

b. Depress the GND switch on the vertical input coupling selector. Using the vertical attenuator switch in the .5V/Div and 1V/Div ranges, adjust the range offset control, R117, until there is no DC shift in the trace, when switching the vertical attenuator switch between the .5V/Div and 1V/Div ranges.

c. Using the vertical vernier control, move the control from the calibrated position to the fully uncalibrated position. Adjust the vernier offset control, R130, until there is no DC shift of the trace, when moving the vertical vernier from one end to the other.

d. Connect the voltmeter to one of the vertical output stand-offs. Using the vertical positioning control, set the positioning control until the voltmeter reads 0vdc $\pm$ 1.0vdc. Move the voltmeter test lead to the second vertical output stand-off. Note the voltmeter amplitude and polarity readings. Adjust the vertical squash control, R194, until the voltmeter reads one-halve of the noted voltage. Move the voltmeter test lead back to the first vertical output stand-off, repeat the above steps until both of the vertical output stand-offs measure 0vdc $\pm$ 1.0vdc.

e. Connect the voltmeter test lead to TP(Trig). Adjust the trigger pick-off bias control, R158, until the voltmeter reads 0vdc $\pm$ 0.01vdc.

f. Depress the DC coupling switch on the vertical input coupling selector. Set the vertical attenuator to the 1V/Div range. Set the frequency of the square wave generator to 1KHz. Adjust the attenuator compensation capacitor, C602, for the best square wave response on the CRT, with no over or undershoot.

g. Disconnect the cable from the vertical input BNC connector and the square wave generator and connect a 10:1 probe to the vertical input BNC connector.

NOTE

If Model 975 DMM/Counter is included with the Oscilloscope, disregard paragraphs h and i and proceed to paragraph j.

Figure 5-2 Location of Rear Panel Controls Model PS915

h. Connect the tip and ground clip to the square wave generator output. Return the vertical attenuator switch to the .5V/Div range. Increase the amplitude of the generator output for a display of 5 major divisions. Adjust the compensation in the probe for the best square wave response on the CRT.

i. Place the vertical attenuator switch to the 1V/Div range. Adjust the 10:1 probe compensation capacitor, C603, for the best square wave display on the CRT, with no over or undershoot.

NOTE

If Model 975 DMM/Counter is not included with the oscilloscope, disregard paragraph j through 1. Perform steps h and i before proceeding to step m.

j. Connect the tip and ground clip of the 10:1 probe to the square wave generator output. Return the vertical attenuator switch to the .5V/Div range. Increase the amplitude of the generator output for a display of 5 major divisions. On the Model 975 DMM/Counter, depress the SCOPE switch. Adjust the compensation in the probe for the best square wave response on the CRT.

k. On the Model 975 DMM/Counter, depress the DC select switch. Adjust capacitor, C52, (on the Model 975 DMM/Counter) until there is no change in the display, when switching from DC to SCOPE on the Model 975 DMM/Counter. Leave the switch in the SCOPE position.

l. Place the vertical attenuator switch to the 1V/Div range. Adjust the 10:1 probe compensation capacitor, C603, for the best square wave display on the CRT, with no over or undershoot.

m. Disconnect the 10:1 probe from the vertical input BNC connector and the square wave generator. Connect the output of the constant amplitude generator to the vertical input BNC connector. Set the output of the constant amplitude generator to 50KHz and the amplitude to 3v P-P, calibrated. Set the vertical attenuator switch to the .5V/Div range, vernier to Calibrate. Set the Time/Div switch to the 10us/Div range. Adjust the vertical amplitude calibration control, R153, for an exact full scale display.

5-18. HORIZONTAL/X CHANNEL AMPLIFIER CALIBRATION

a. Rotate the stability control, R34, clockwise until the display loses sync and starts to free-run. Mark this spot with a pencil or an ink pen. Rotate the control counter-clockwise until the trace disappears, mark this spot with the pencil,

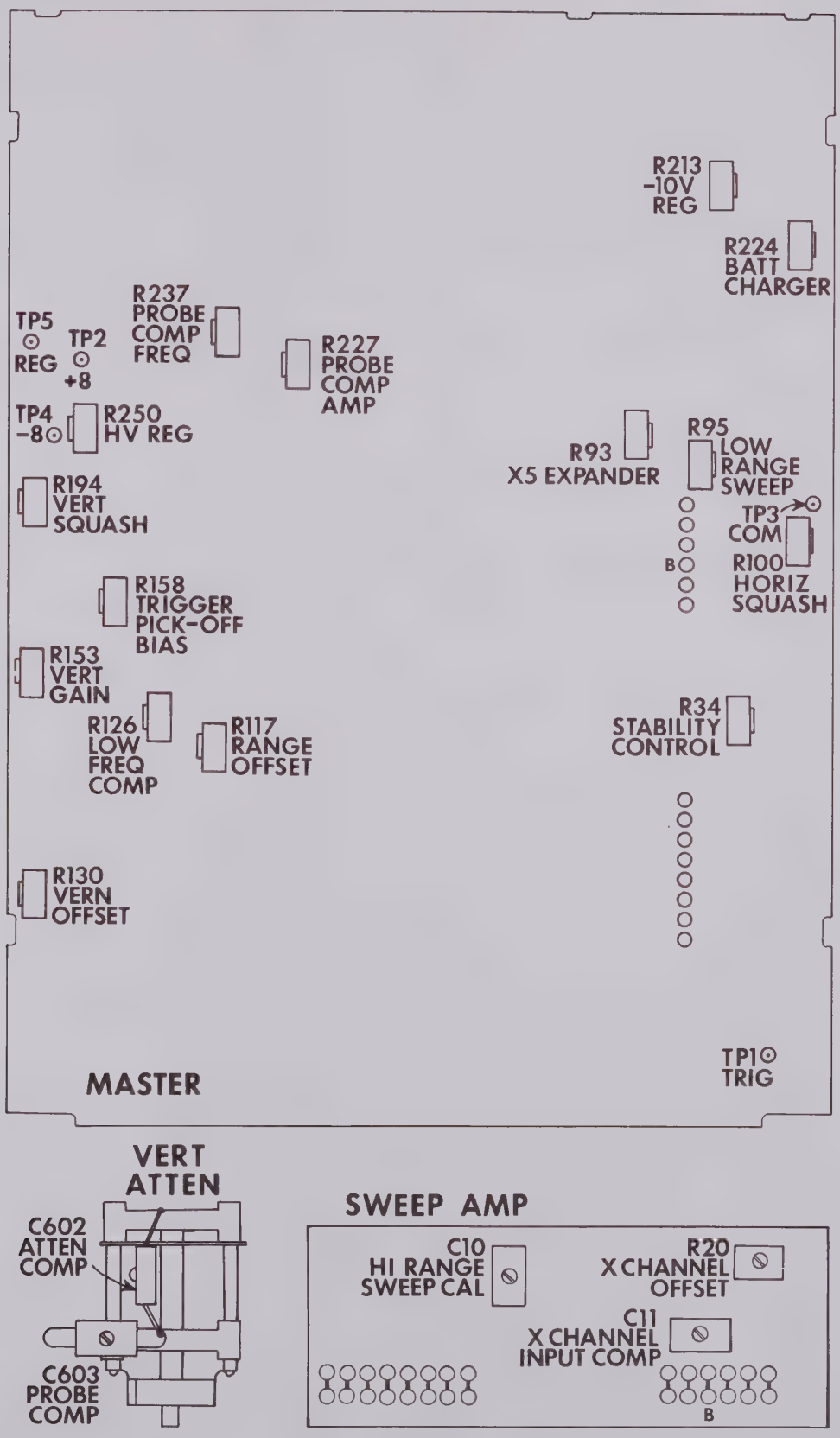


Figure 5-3. PS915 Calibration Adjustment Location

then set the potentiometer until it is halve way between the two marks.

b. Disconnect the constant amplitude generator from the vertical input BNC connector. Rotate the Time/Div switch to the 1V/Div range. Rotate the X Channel Gain vernier through its full range and note if there is any horizontal shift of the dot on the CRT. Adjust X Channel offset control, R20, located on the sweep amplifier sub-assembly, to remove any horizontal shift on the CRT.

c. Connect the square wave generator to the X input BNC connector. Set the Time/Div switch to the .1V/Div range, vernier to Calibrate. Set the frequency of the generator to 1KHz and the amplitude control for a full scale display on the CRT. Connect an oscilloscope to pin "B" on the sweep amplifier sub-assembly. Adjust the X amplifier square wave compensation capacitor, C11, located on the sweep amplifier sub-assembly for a good square wave response on the oscilloscope, with no over or undershoot.

NOTE

When connecting the oscilloscope to connector pin "B", keep the probe as far away from C11 as possible.

d. Disconnect the square wave generator from the X amplifier input BNC connector. Connect the voltmeter to one of the horizontal output stand-offs. Using the horizontal positioning control, set the positioning control until the voltmeter reads 0vdc $\pm$1.0vdc. Move the voltmeter to the second horizontal output stand-off. Note the voltmeter amplitude and polarity readings. Adjust the horizontal squash control, R100, until the voltmeter reads one-halve of the noted voltage. Move the voltmeter test lead back to the first horizontal output stand-off, repeat the above steps until both of the horizontal output stand-offs measure 0vdc $\pm$1vdc.

e. Connect the sine wave generator to both the vertical input BNC connector and to the frequency counter. Adjust the amplitude of the generator output for approximately 5 divisions of display. Using the frequency counter, adjust the frequency of the generator output for 10KHz. Rotate the Time/Div switch to the .1ms/Div range, vernier to Calibrate. Adjust the low range sweep calibration control, R95, until there is one peak of the sine wave for each of the vertical graticule lines. Use the horizontal positioning control as required to line up the sine wave with the graticule lines.

f. Rotate the Time/Div switch to the .1us/Div range, vernier to Calibrate. Set the frequency of the generator to 10MHz as verified by the counter.

Adjust the high range sweep calibration control, C10, (located on the sweep amplifier sub-assembly) until there is one peak of the sine wave for each of the vertical graticule lines. Again, use the horizontal positioning control as required to line up the sine wave with the graticule lines.

g. Pull the X5 Expander control, adjust the X5 Expander calibration control, R93, until there are two complete cycles of the sine wave for a full scale display. Again, use the positioning control to line up the sine wave with a graticule mark on the ends of the graticule.

1 us
200 ns marks

5-19. CALIBRATOR ADJUSTMENT

a. Connect the oscilloscope to the PROBE COMP output. Adjust the PROBE COMP output amplitude control, R227, for exactly 1V P-P amplitude.

b. Connect the frequency counter to the PROBE COMP output. Adjust the PROBE COMP frequency control, R237, until the counter reads 1KHz $\pm$ 20Hz.

5-20. MODEL 975 DMM/COUNTER CALIBRATION PROCEDURE

The following procedure provides the calibration steps required for calibrating the Model 975 DMM/Counter. Since the operating power for the DMM/Counter is derived from the PS915 Oscilloscope, the calibration procedure for the PS915 Oscilloscope should be performed prior to any attempt to calibrate the DMM/Counter.

5-21. Test Equipment Required

The following is the list of test equipment required to calibrate the DMM/Counter. Substitution of test equipment is authorized provided that the basic accuracy of the substituted equipment meets or exceeds the specified accuracy of the listed equipment.

1. Digital Voltmeter - Data Tech Model 30
2. Frequency Counter - H-P Model 5325A
3. Function Generator - H-P Model 3310A
4. DC Voltage Standard - .01% Accuracy
5. AC Voltage Standard - .01% Accuracy
6. Ohms Standard - .01% Accuracy

5-22. Location of Controls for Alignment

The location for the calibration controls and test points are illustrated in Fig. 5-4.

5-23. DMM/Counter Master Clock Calibration

a. Connect the sine wave generator to both the vertical input BNC connector and the frequency counter. Set the generator frequency to approximately 80KHz and the amplitude for a suitable triggered display on the CRT. On the DMM/Counter, depress the 100KHz counter range.

b. Adjust the Master Clock calibration control, C1, until the digital display on the DMM/Counter agrees with the display of the external counter.

c. Increase the frequency of the sine wave generator to approximately 160KHz. Verify that the visible numbers on the flashing display of the DMM/Counter are within the specification limits of the DMM/Counter, in the over-range mode. Readjust the Clock calibration control, if required.

d. Connect the constant amplitude generator to the vertical input BNC connector. Adjust the amplitude control for a display of one (1) major division and a frequency of 20MHz.

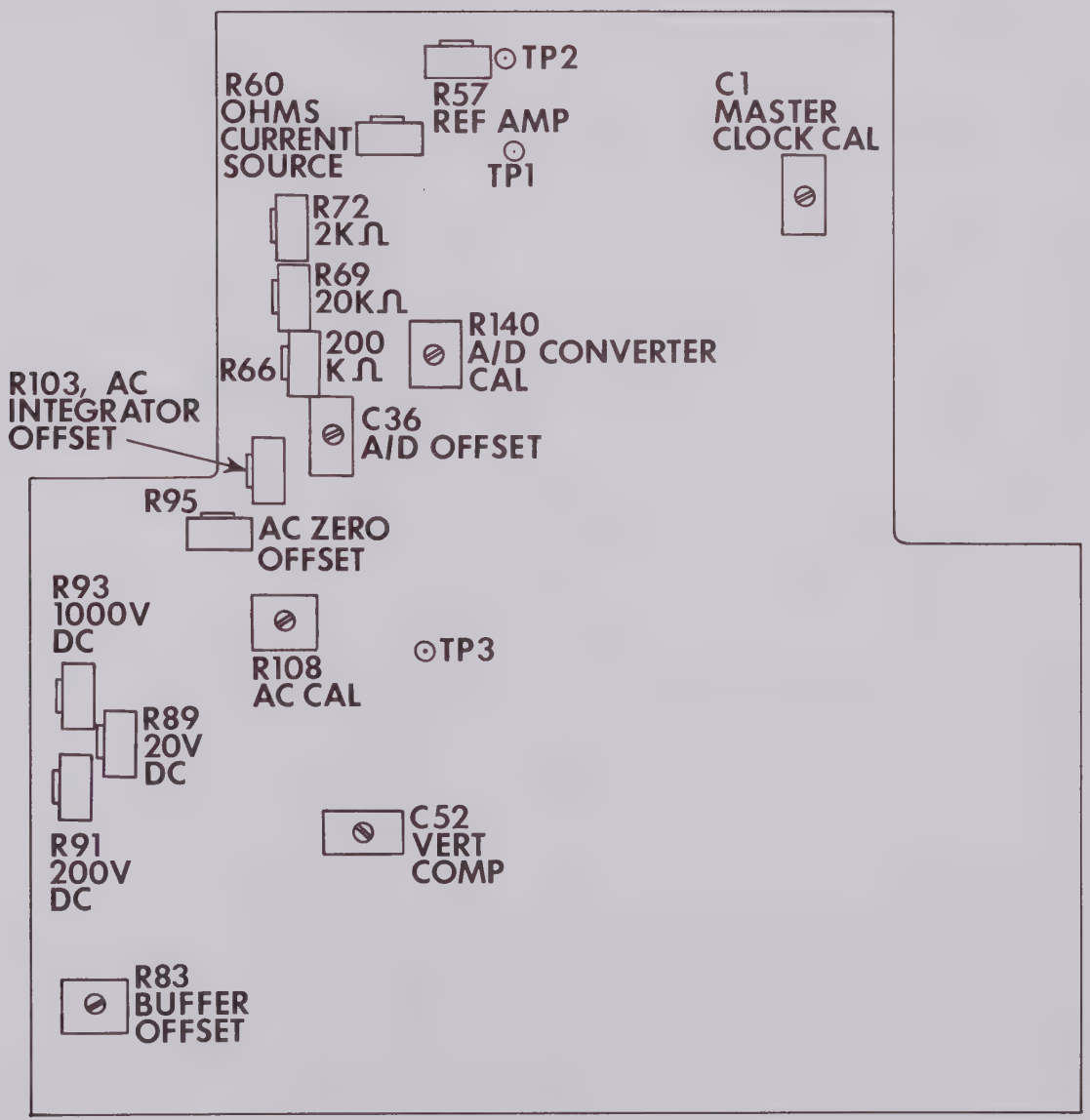


Figure 5-4. Model 975 Calibration Adjustment Location

Adjust the trigger level control to obtain a count on the Model 975 Counter. If you do not obtain both a count on the counter and a display on the oscilloscope, adjust the stability control, R34, (on the PS915) clockwise until you can obtain both a count and display. Recheck the oscilloscope at a low frequency (50KHz) to verify that the stability control has not been set into the free-run region.

5-24. Reference Voltage Calibration

a. Connect the plus and minus leads of the digital voltmeter across sensing resistor, R54, (test points are provided-TP1-High, TP2-Gnd).

b. Adjust Reference amplifier control, R57, for a digital voltmeter reading of +0.602vdc ± 0.001vdc.

5-25. A-D Converter Zero Adjust

a. Place a jumper from analog ground (negative terminal of AUX INPUT) to the A-D converter input resistor (TP-3). Depress DMM DCV function.

b. Adjust the A-D converter offset control, C36, for a DMM digital display of -.000. Remove the jumper from TP-3.

5-26. DC Voltage Offset Adjust

a. Connect a set of test leads to the DMM/Counter AUX INPUT connectors, short the probe ends of the test leads together.

b. Adjust Buffer Amplifier offset control, R83, for a digital display of -.000vdc.

5-27 DC Voltage Calibration

a. Connect the AUX INPUT test leads to the DC Voltage standard. Set the DC voltage standard for a voltage of +1.950vdc.

b. Adjust the A-D Converter calibration control, R140, for a DMM display of +1.950vdc ± 1 digit.

c. Increase the output of the DC voltage standard to +19.95vdc.

d. Adjust the Buffer Amplifier 20 volt range control, R89, for a DMM digital display of +19.95vdc ± 1 digit.

e. Increase the output of the DC voltage standard to 195.0vdc.

f. Adjust the Buffer Amplifier 200 volt range control, R91, for a DMM digital display of +195.0vdc ± 1 digit.

g. Increase the output of the DC voltage standard to 1000vdc.

h. Adjust the Buffer Amplifier 1000 volt range control, R93, for a DMM digital display of +1000vdc ± 1 digit.

5-28. AC Converter Calibration

a. Turn off the input power, unsolder and remove the top shield from the DMM function switch and the two test points at the rear of the shield. Using a jumper cable, connect one end of the jumper to the positive end of the tantalum capacitor, C29, and the other end to analog ground. Turn the input power back on. On the DMM/Counter, depress the ACV function.

b. Adjust the AC integrator offset control, R103, until the DMM digital display indicates an in-range reading (a flashing display is an out-of-range indication).

NOTE

With the integrating capacitor shorted out, the integrating amplifier is running at an open-loop gain. The previous adjustment (step b) eliminates the input offset voltage from the amplifier as a possible source of error. This adjustment may be a little difficult to set.

c. Turn off the input power and remove the jumper from the positive end of tantalum capacitor, C29. Replace and resolder the top shield to the two test points and the two rear contacts of the OHM switch. Turn the input power back on. Short the two AUX INPUT leads together.

d. Adjust the AC zero offset control, R95 , for a DMM digital display of -.000vac.

e. Connect the two AUX INPUT test leads to the AC voltage standard. Set the AC voltage standard for an output of 1.900vac at a frequency of 1KHz.

f. Adjust the AC calibration control, R108, for a digital display of 1.900vac ± 1 digit.

5-29 Ohms Converter Calibration

a. On the DMM/Counter, depress the KOHMS function. Connect the AUX INPUT test leads to the Ohms standard. Set the Ohms standard for 1.950Meg ohm.

b. Adjust the ohms converter current source, R60, for a digital display of 1950K ohms.

c. Decrease the ohms standard to 195.0K ohms.

NOTE

In order to obtain the proper range, it may be necessary to momentarily depress the DCV function and then back to the KOHM function. This allows the DMM to uprange into the 200K ohm range since it cannot down-range with the value of ohms standard being used for this range.

d. Adjust the 200K ohm range control, R66, for a digital display of 195.0K ohms $\pm$ 1 digit.

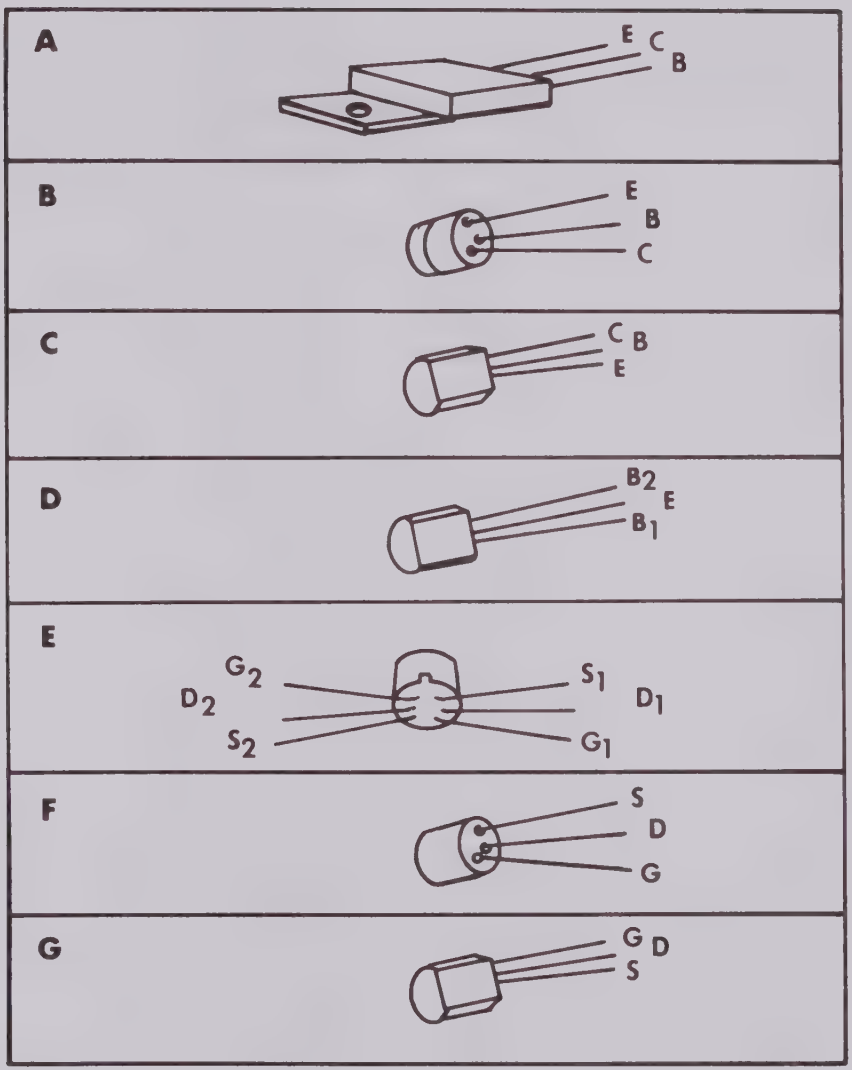
e. Decrease the ohms standard to 19.50K ohms.

f. Adjust the 20K ohm range control, R72, for a digital display of 19.50K ohm $\pm$ 1 digit.

g. Decrease the ohm standard to 1.950K ohm.

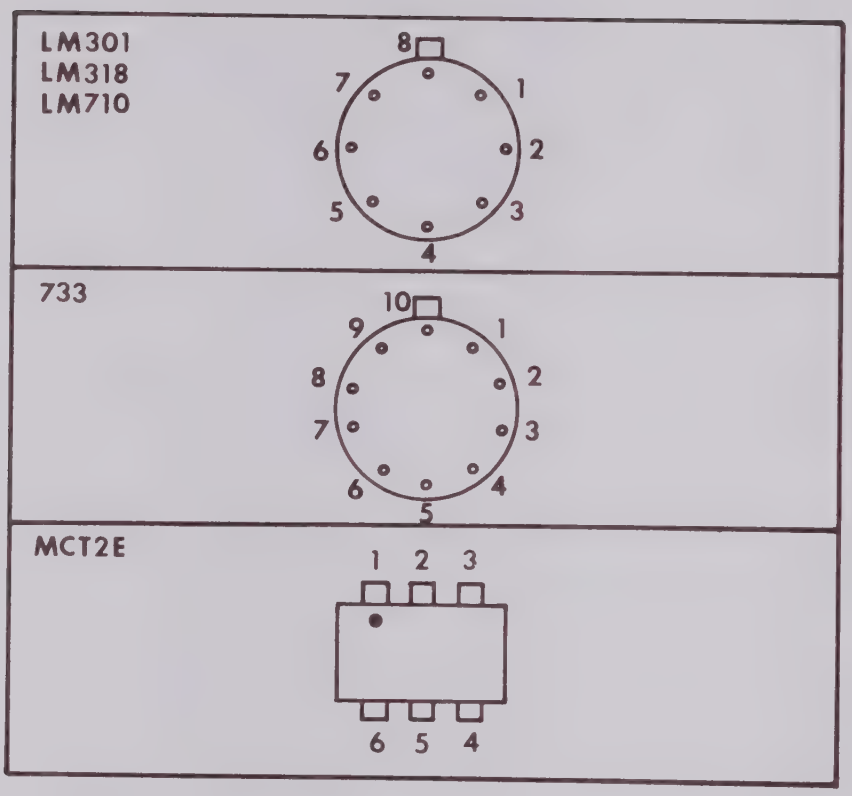
h. Adjust the 2K ohm range control, R72, for a digital display of 1.950K ohm $\pm$ 1 digit.

PS 915

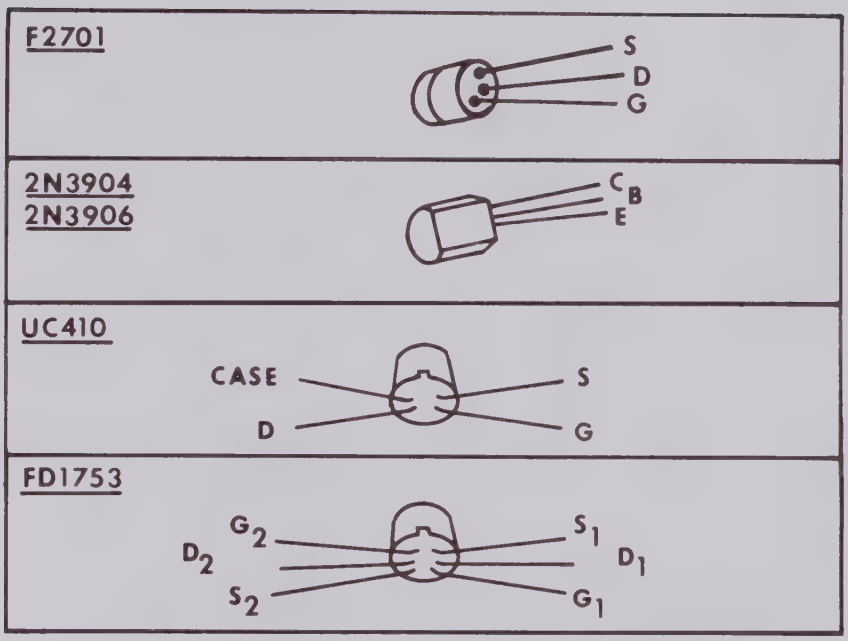


A	D44C3		MPSH04
	D44H2		MPSH54
			MPSA43
B	2N3646		
	2N3694	D	2N4870
	2N4250		
	2N4275	E	FD1753
C	2N3904		
	2N3906	F	F2701
	2N5401		
	2N5550	G	F2762

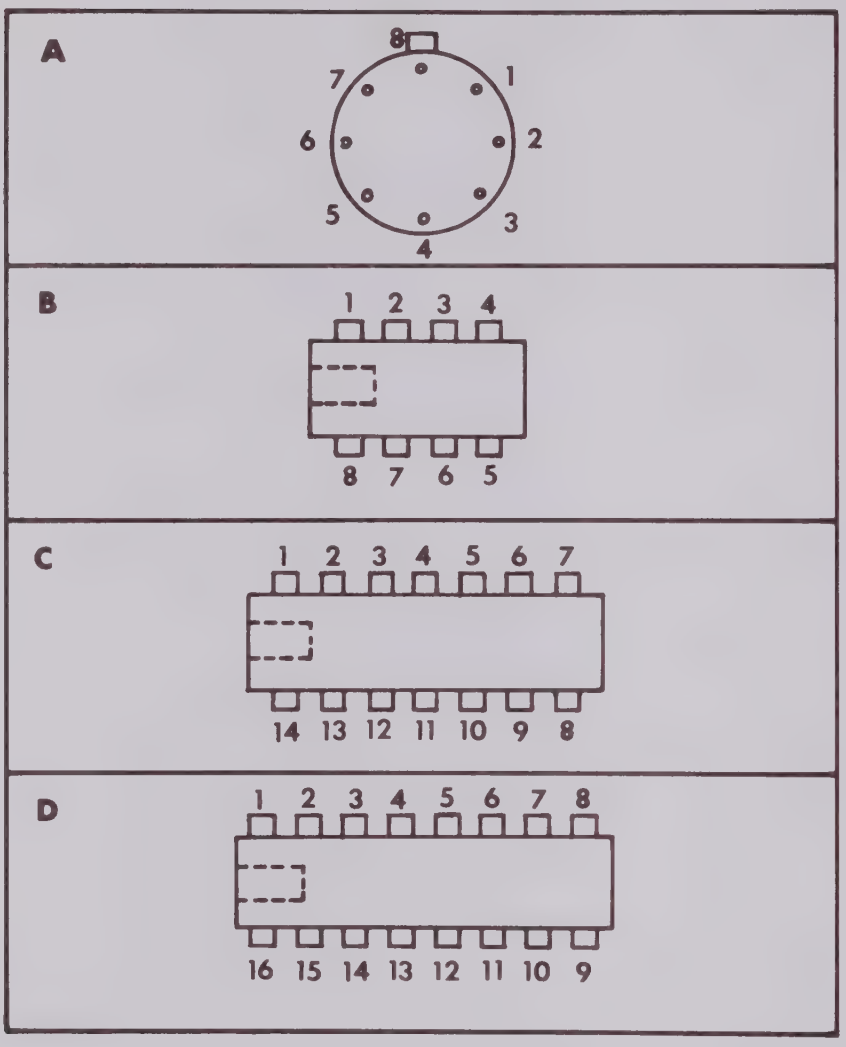
PS 915



MODEL 975


F2701
S
D
G
2N3904
2N3906
C
B
E
UC410
CASE
S
D
G
FD1753
G2
S1
D2
D1
S2
G1

MODEL 975



A LM301
LM318
SN74L20
SN74L90

B NE555

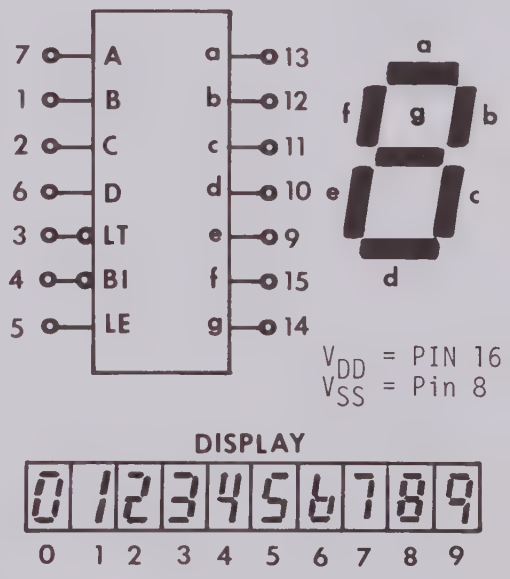
C SN74L502
SN74LS196
SN7416
SN74L10

D MK5007P
LD110
LD111
SN74L576
SN74L96
MC14020
MC14511

MC14511

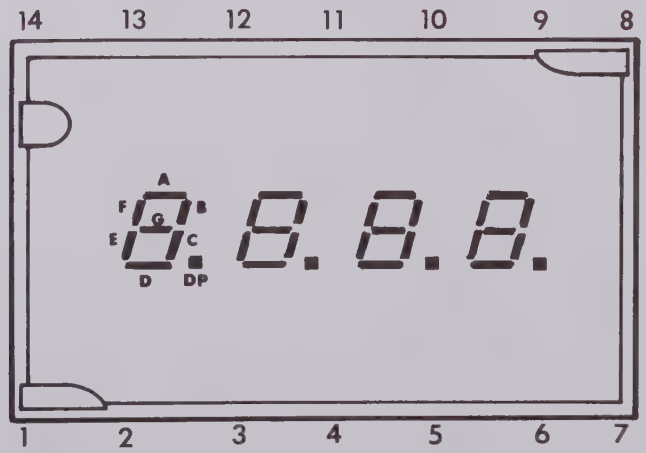
TRUTH TABLE

INPUTS						OUTPUTS							
LE	$\overline{BI}$	$\overline{LT}$	D	C	B	A	a	b	c	d	e	f	g	DISPLAY
X	X	0	X	X	X	X	1	1	1	1	1	1	1	8
X	0	1	X	X	X	X	0	0	0	0	0	0	0	Blank*
0	1	1	0	0	0	0	1	1	1	1	1	1	0	0
0	1	1	0	0	0	1	0	1	1	0	0	0	0	1
0	1	1	0	0	1	0	1	1	0	1	1	0	1	2
0	1	1	0	0	1	1	1	1	1	1	0	0	1	3
0	1	1	0	1	0	0	0	1	1	0	0	1	1	4
0	1	1	0	1	0	1	1	0	1	1	0	1	1	5
0	1	1	0	1	1	0	0	0	1	1	1	1	1	6
0	1	1	0	1	1	1	1	1	1	0	0	0	0	7
0	1	1	1	0	0	0	1	1	1	1	1	1	1	8
0	1	1	1	0	0	1	1	1	1	0	0	1	1	9
0	1	1	1	0	1	0	0	0	0	0	0	0	0	Blank
0	1	1	1	0	1	1	0	0	0	0	0	0	0	Blank
0	1	1	1	1	0	0	0	0	0	0	0	0	0	Blank
0	1	1	1	1	0	1	0	0	0	0	0	0	0	Blank
0	1	1	1	1	1	0	0	0	0	0	0	0	0	Blank
0	1	1	1	1	1	1	0	0	0	0	0	0	0	Blank
1	1	1	X	X	X	X	*							*



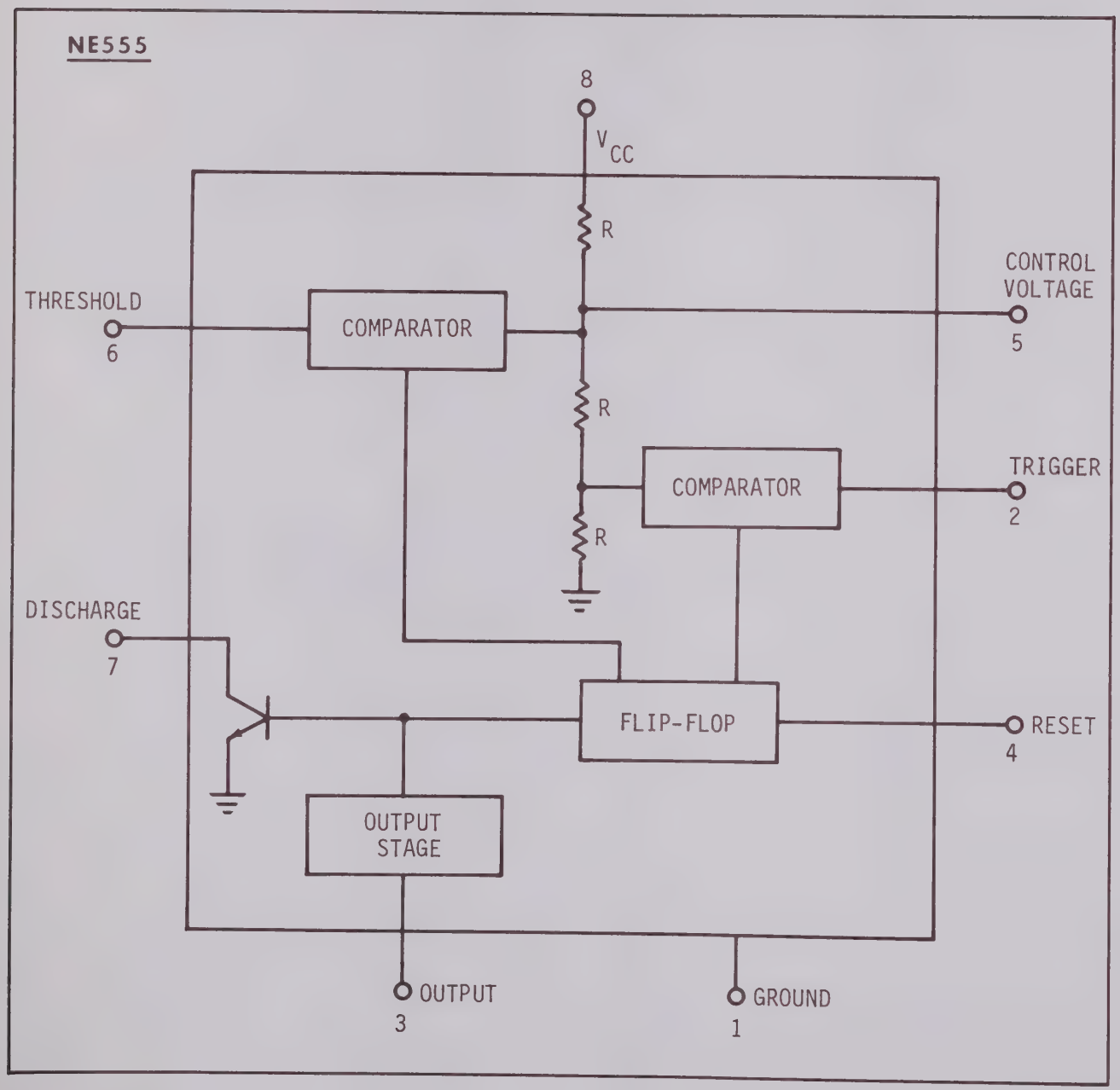
X = Don't care; * Depends upon the BCD code applied during the 0 to 1 transition of LE.

PIN CONFIGURATION DL-34M

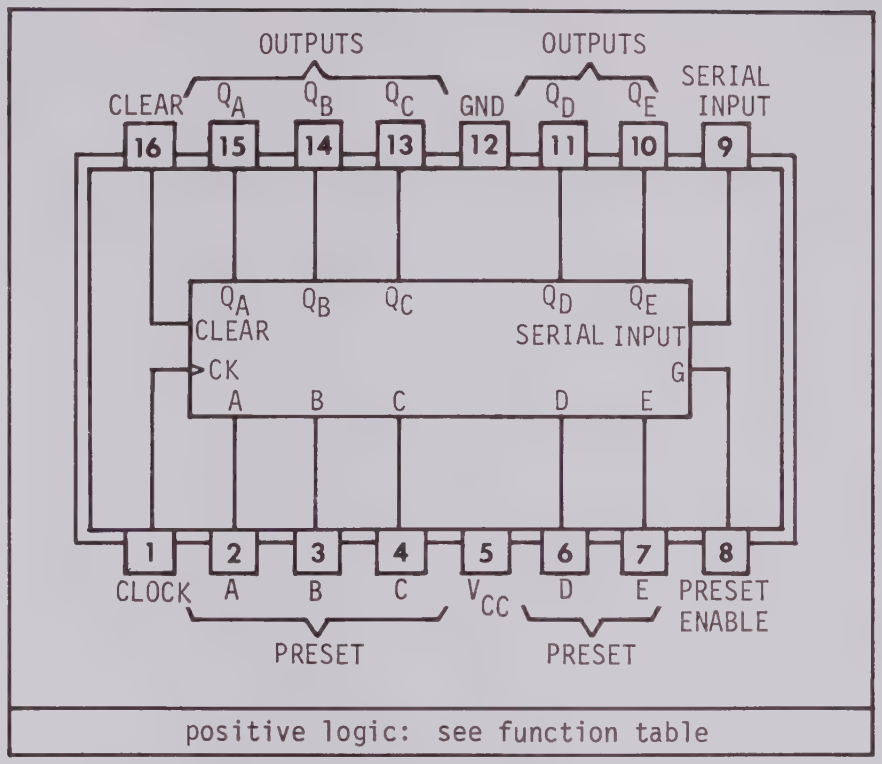


Note: There are no pins in positions 1 and 8.

PIN	FUNCTION
1	NC
2	ANODE E
3	ANODE D
4	ANODE C
5	DEC.PT.ANODE
6	ANODE G
7	CATHODE 4
8	NC
9	ANODE B
10	CATHODE 3
11	ANODE F
12	CATHODE 2
13	ANODE A
14	CATHODE 1


NE555
8
V_{CC}
R
R
R
CONTROL VOLTAGE
5
THRESHOLD
6
COMPARATOR
COMPARATOR
TRIGGER
2
DISCHARGE
7
FLIP-FLOP
RESET
4
OUTPUT STAGE
OUTPUT
3
GROUND
1

SN74L96



positive logic: see function table

FUNCTION TABLE

INPUTS									OUTPUTS				
CLEAR	PRESET ENABLE	PRESET A	B	C	D	E	CLOCK	SERIAL	Q_A	Q_B	Q_C	Q_D	Q_E
L	L	X	X	X	X	X	X	X	L	L	L	L	L
L	X	L	L	L	L	L	X	X	L	L	L	L	L
H	H	H	H	H	H	H	X	X	H	H	H	H	H
H	H	L	L	L	L	L	L	X	Q_{AO}	Q_{BO}	Q_{CO}	Q_{DO}	Q_{EO}
H	H	H	L	H	L	H	L	X	H	Q_{BO}	H	Q_{DO}	H
H	L	X	X	X	X	X	L	X	Q_{AO}	Q_{BO}	Q_{CO}	Q_{DO}	Q_{EO}
H	L	X	X	X	X	X	↑	H	H	Q_{An}	Q_{Bn}	Q_{Cn}	Q_{Dn}
H	L	X	X	X	X	X	↑	L	L	Q_{An}	Q_{Bn}	Q_{Cn}	Q_{Dn}

H = high level (steady state), L = low level (steady state)

X = irrelevant (any input, including transitions)

↑ = transition from low to high level

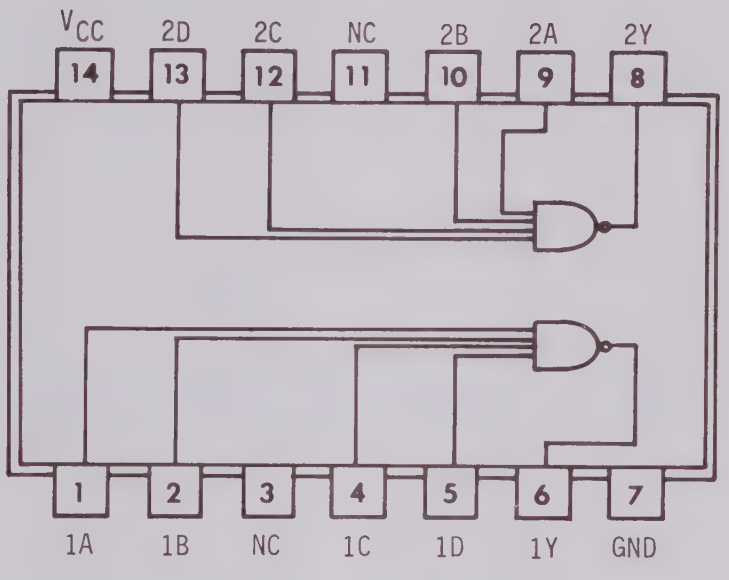
SN74L20

DUAL 4-INPUT

POSITIVE-NAND GATES

positive logic:

$Y = \overline{ABCD}$



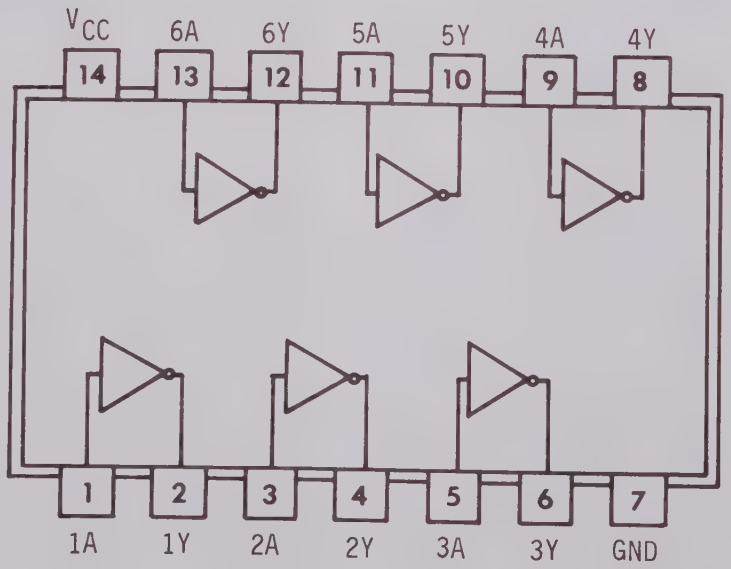
SN54L20/SN74L20(J, N)

SN7416

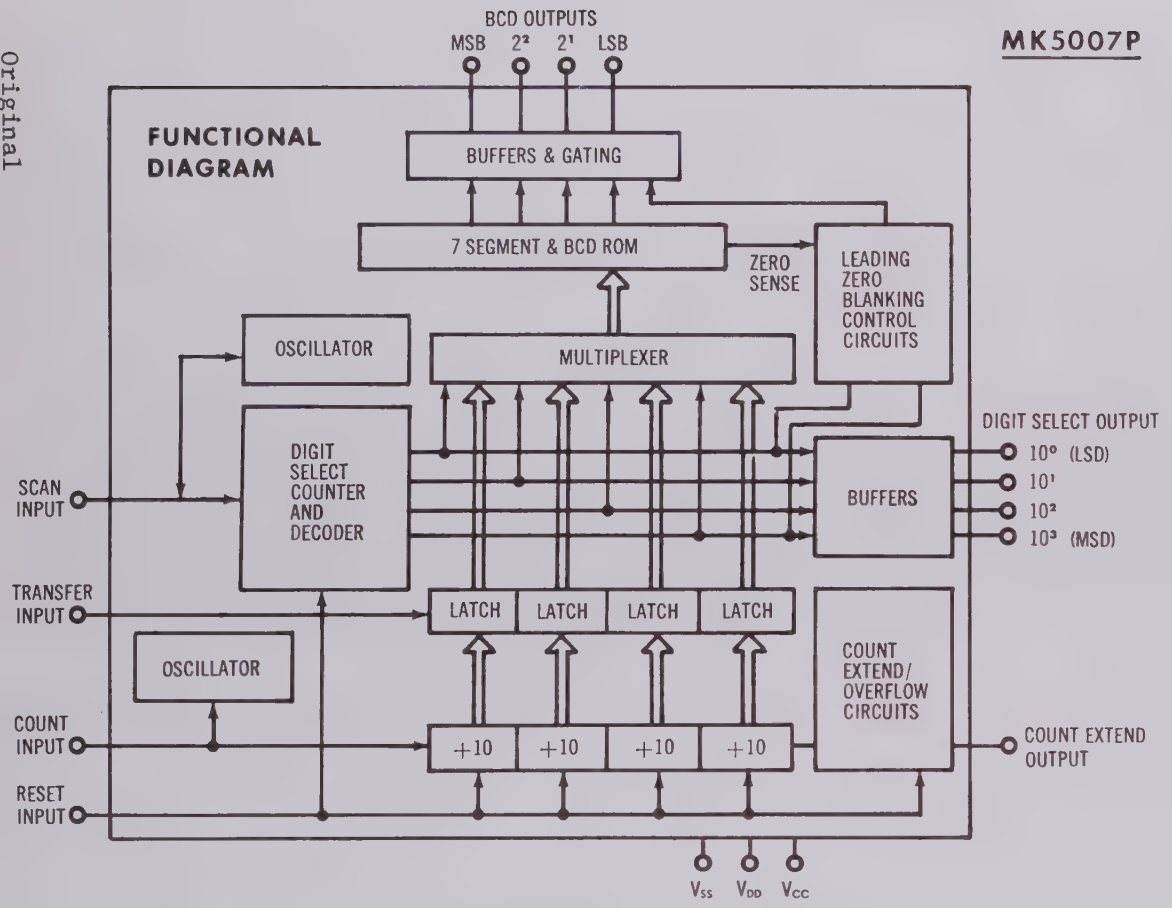
HEX INVERTER BUFFERS/ DRIVERS WITH OPEN COLLECTOR HIGH-VOLTAGE OUTPUTS

positive logic:

$Y = \overline{A}$



SN5416/SN7416(J, N, W)



7-SEGMENT & BCD OUTPUTS TRUTH TABLE													
		DISPLAY SEGMENT							BCD				
Digit	Scan	a	b	c	d	e	f	g	MSB	2^2	2^1	LSB	
0	1	0	0	0	0	0	0	1	1	1	1	1	
1	1	1	0	0	1	1	1	1	1	1	1	0	
2	1	0	0	1	0	0	1	0	1	1	0	1	
3	1	0	0	0	0	1	1	0	1	1	0	0	
4	1	1	0	0	1	1	0	0	1	0	1	1	
5	1	0	1	0	0	1	0	0	1	0	1	0	
6	1	0	1	0	0	0	0	0	1	0	0	1	
7	1	0	0	0	1	1	1	1	1	0	0	0	
8	1	0	0	0	0	0	0	0	0	1	1	1	
9	1	0	0	0	0	1	0	0	0	1	1	0	
X	0	1	1	1	1	1	1	1	1	1	1	1	
True/Complement = Logic 1													

TRUTH TABLE, OTHER OUTPUTS		
Output	True Logic State	Time of Occurrence
Digit Select Outputs	1	One-of-four, following Scan Input rising edge; all off when Scan Input is low.
$\overline{\text{Overflow}}$ Latch	0	Occurs on the 10,000th Count Input following a reset. Remains true until an external reset is accomplished.
Count Extend	1	Occurs each time the counter state attains 9,999 count. Remains true only until the next Count Input or Reset occurs (when the counter returns to 0,000).

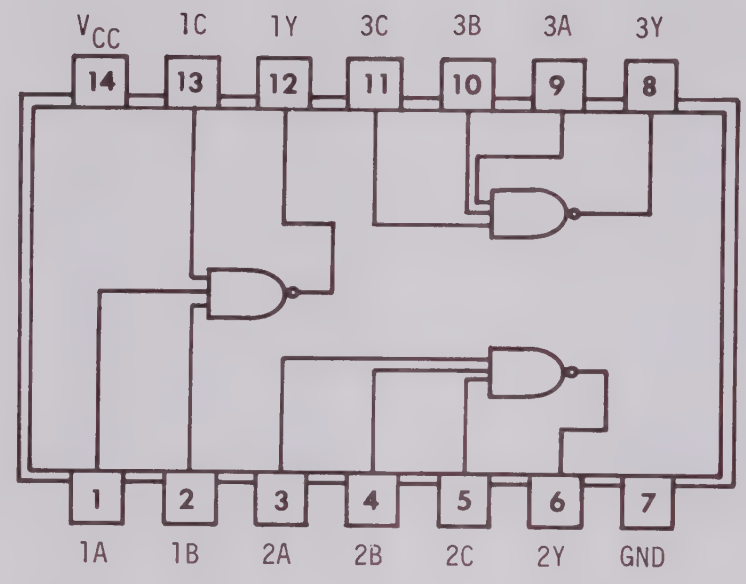
SN74L10

TRIPLE 3-INPUT

POSITIVE-NAND GATES

positive logic:

$Y = \overline{ABC}$



SN54L10/SN74L10(J, N)

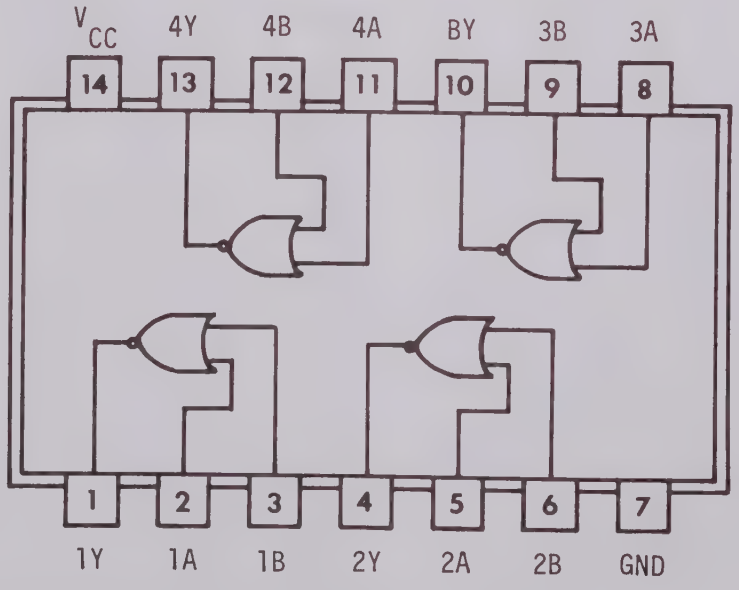
SN74LS02

QUADRUPLE 2-INPUT

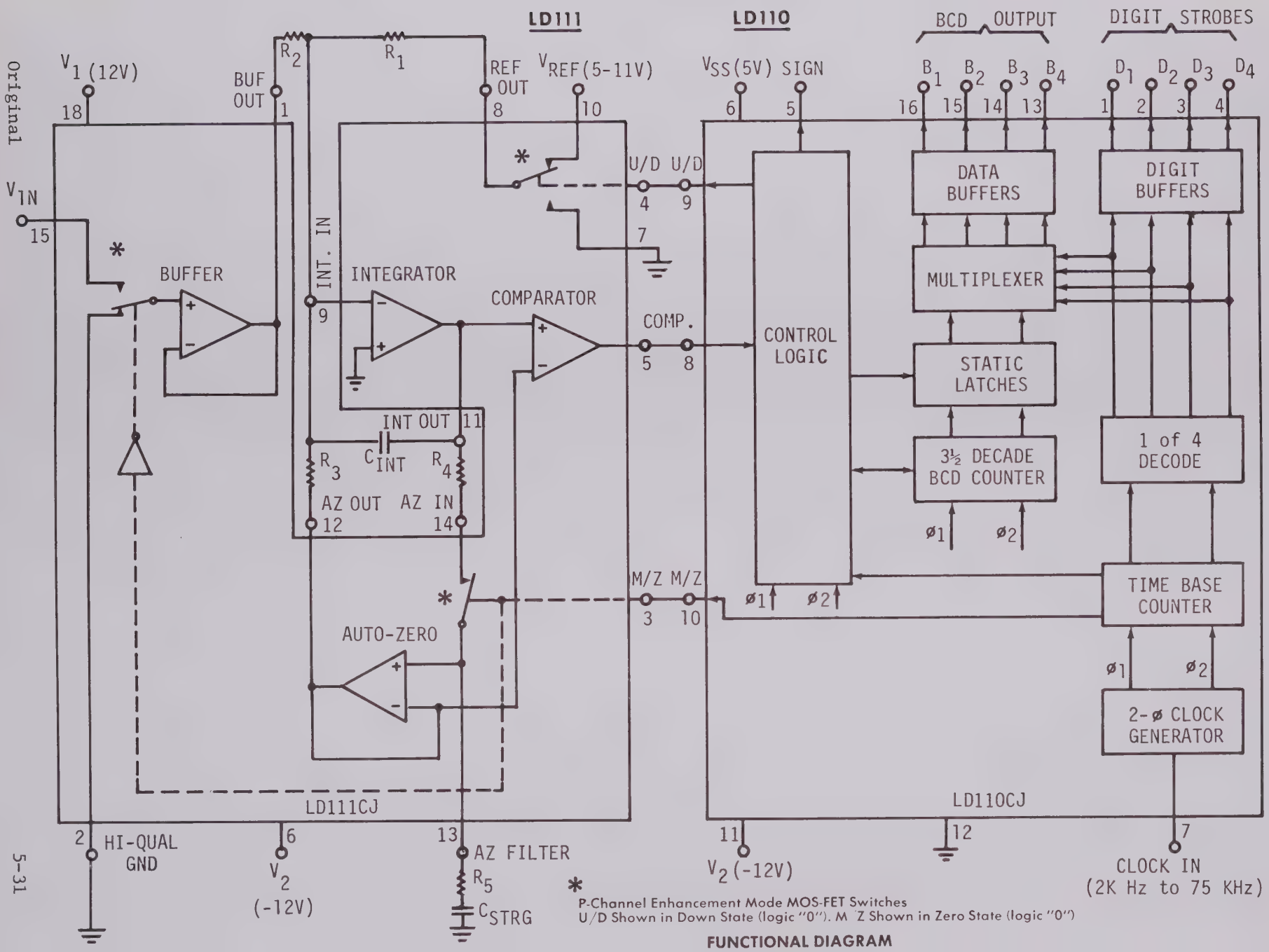
POSITIVE-NOR GATES

positive logic:

$Y = \overline{A+B}$



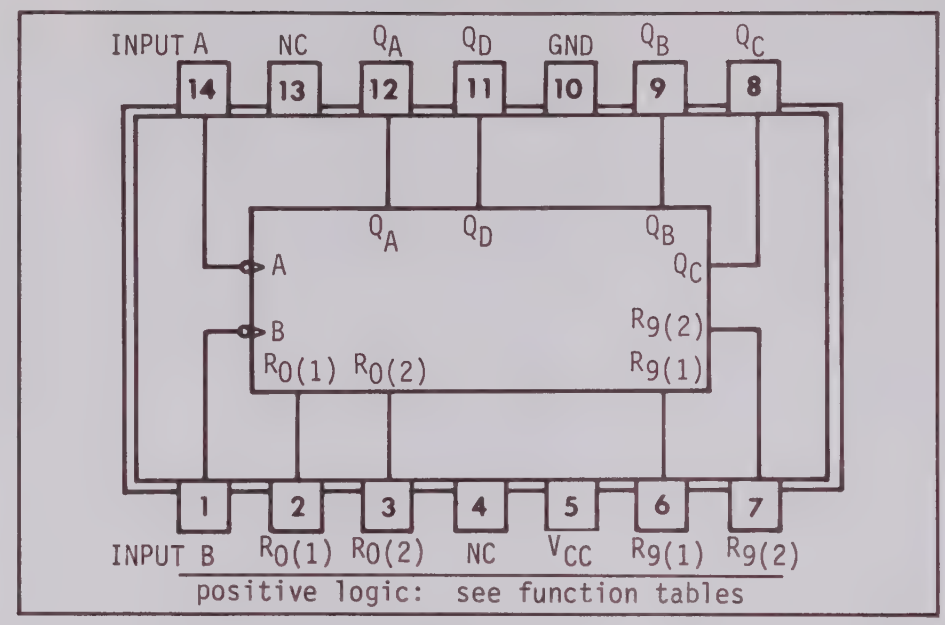
SN54L02/SN74LS02(J, N, W)



P-Channel Enhancement Mode MOS-FET Switches
U/D Shown in Down State (logic "0"). M Z Shown in Zero State (logic "0")

FUNCTIONAL DIAGRAM

SN74L90



TRUTH TABLES

'90A,'L90 BCD COUNT SEQUENCE

COUNT	OUTPUT			
	Q_D	Q_C	Q_B	Q_A
0	L	L	L	L
1	L	L	L	H
2	L	L	H	L
3	L	L	H	H
4	L	H	L	L
5	L	H	L	H
6	L	H	H	L
7	L	H	H	H
8	H	L	L	L
9	H	L	L	H

'90A, 'L90 BI-QUINARY (5-2)

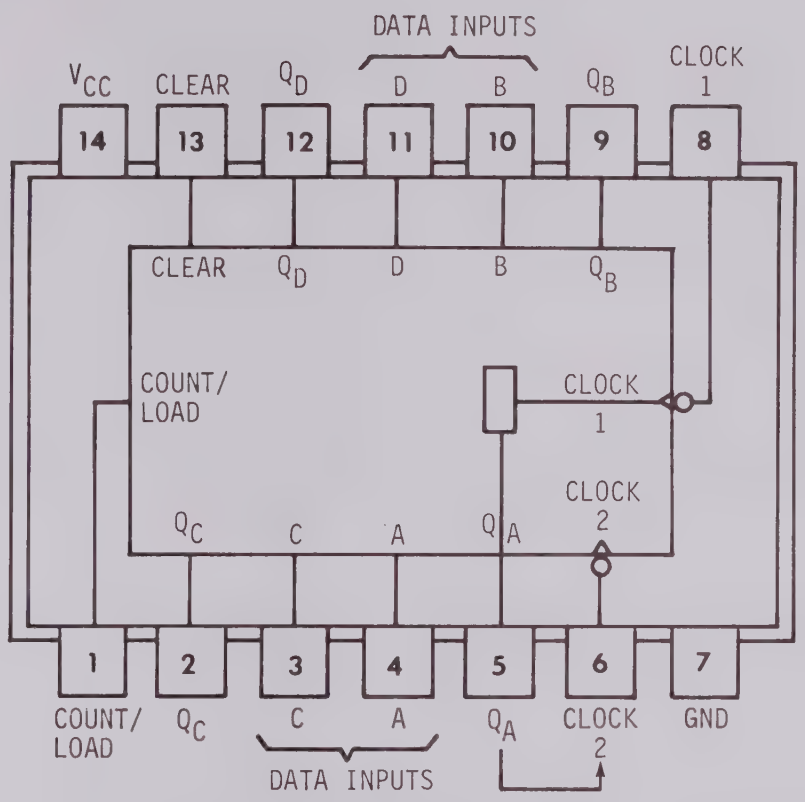
COUNT	OUTPUT			
	Q_A	Q_D	Q_C	Q_B
0	L	L	L	L
1	L	L	L	H
2	L	L	H	L
3	L	L	H	H
4	L	H	L	L
5	H	L	L	L
6	H	L	L	H
7	H	L	H	L
8	H	L	H	H
9	H	H	L	L

'90A,'L90

RESET/COUNT FUNCTION TABLE

RESET INPUTS				OUTPUT
$R_{0(1)}$	$R_{0(2)}$	$R_{9(1)}$	$R_{9(2)}$	Q_D Q_C Q_B Q_A
H	H	L	X	L L L L
H	H	X	L	L L L L
X	X	H	H	H L L H
X	L	X	L	COUNT
L	X	L	X	COUNT
L	X	X	L	COUNT
X	L	L	X	COUNT

SN74LS196



asynchronous inputs: Low input to clear sets Q_A, Q_B, Q_C and Q_D low.

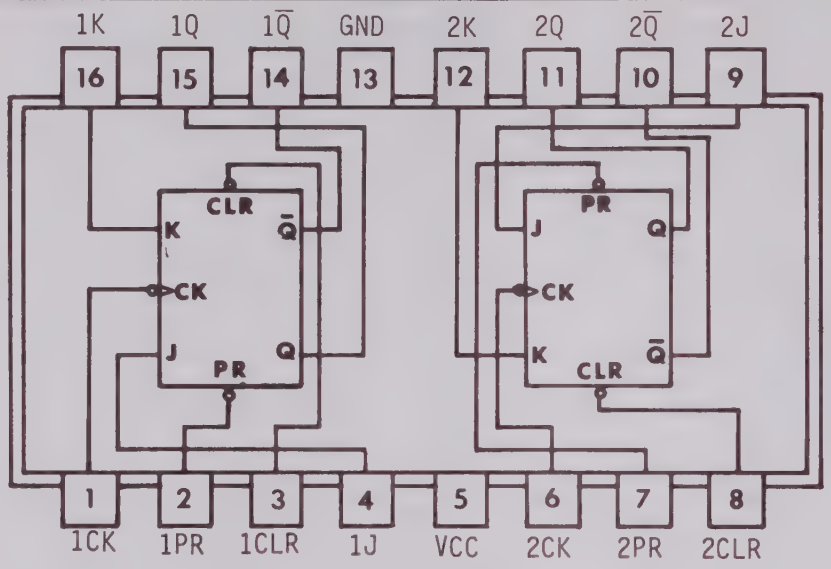
TRUTH TABLE

COUNT	OUTPUT			
	Q_D	Q_C	Q_B	Q_A
0	L	L	L	L
1	L	L	L	H
2	L	L	H	L
3	L	L	H	H
4	L	H	L	L
5	L	H	L	H
6	L	H	H	L
7	L	H	H	H
8	H	L	L	L
9	H	L	L	H

H = high level, L = low level

SN74LS76

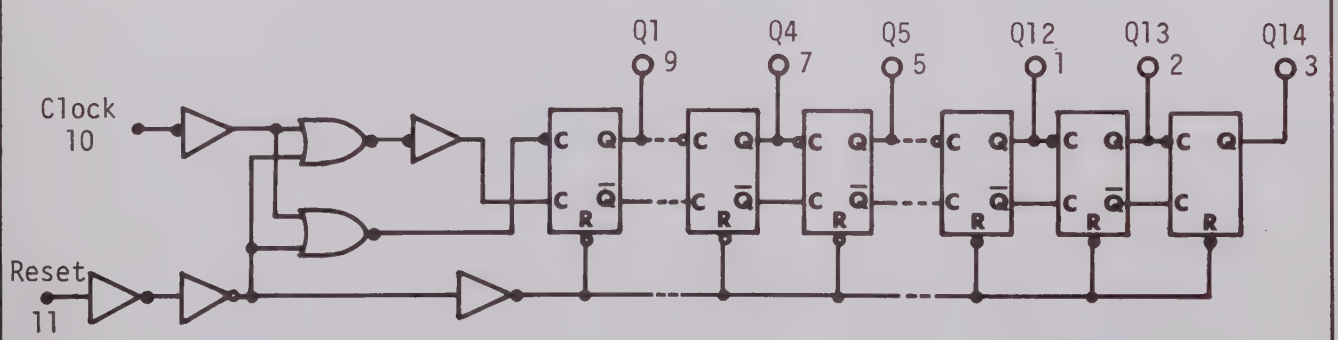
DUAL J-K FLIP-FLOPS WITH PRESET AND CLEAR



'LS76 FUNCTION TABLE

INPUTS					OUTPUTS	
PRESET	CLEAR	CLOCK	J	K	Q	$\overline{Q}$
L	H	X	X	X	H	L
H	L	X	X	X	L	H
L	L	X	X	X	H*	H*
H	H	↓	L	L	Q_0	$\overline{Q}_0$
H	H	↓	H	L	H	L
H	H	↓	L	H	L	H
H	H	↓	H	H	TOGGLE	
H	H	H	X	X	Q_0	$\overline{Q}_0$

MC 14020 LOGIC DIAGRAM



Q6 = Pin 4 Q8 = Pin 13 Q10 = Pin 14 V_{DD} = Pin 16
Q7 = Pin 6 Q9 = Pin 12 Q11 = Pin 15 V_{SS} = Pin 8

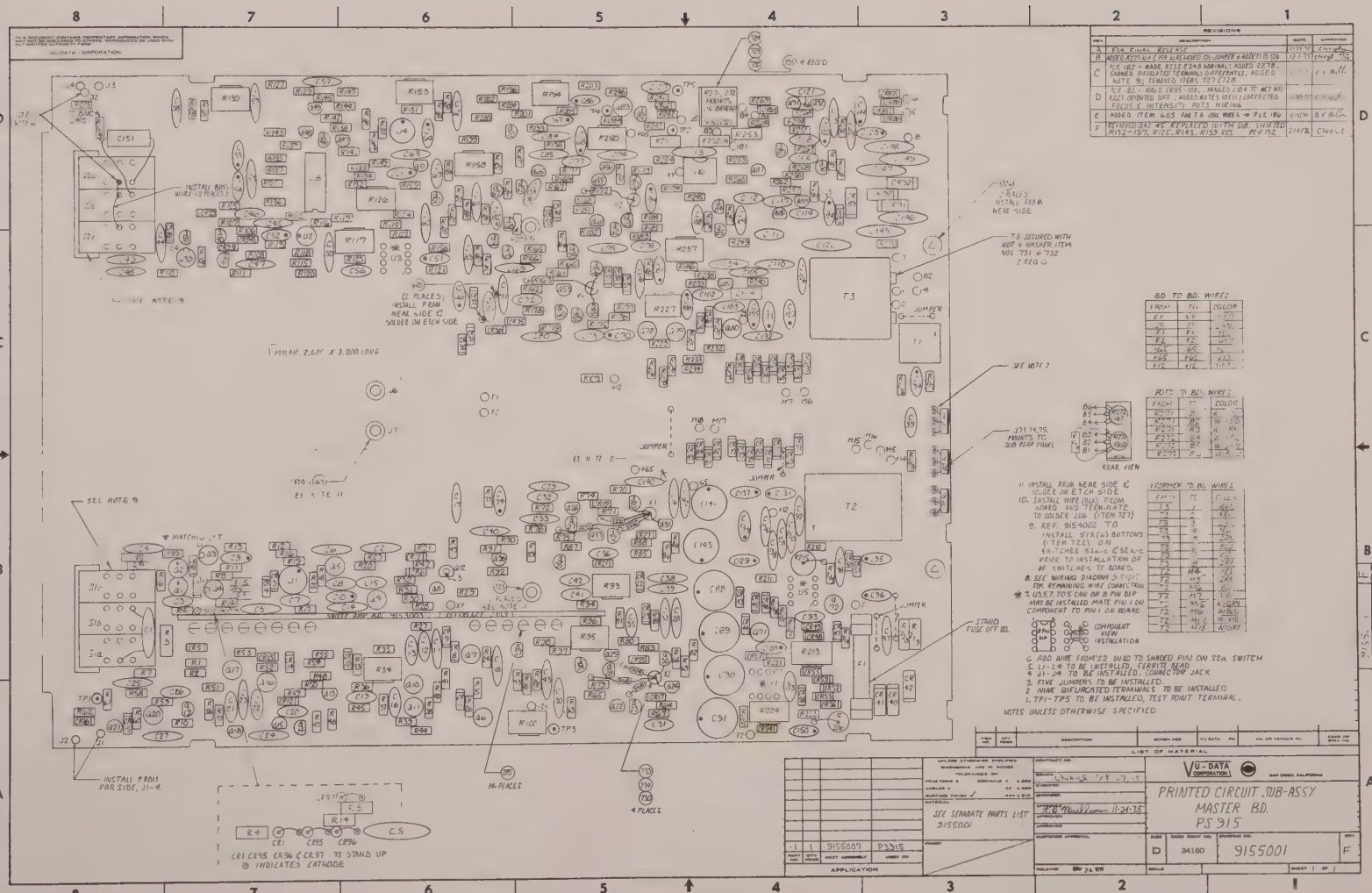


Figure 5-5 Master Board Sub-Assembly 9155001

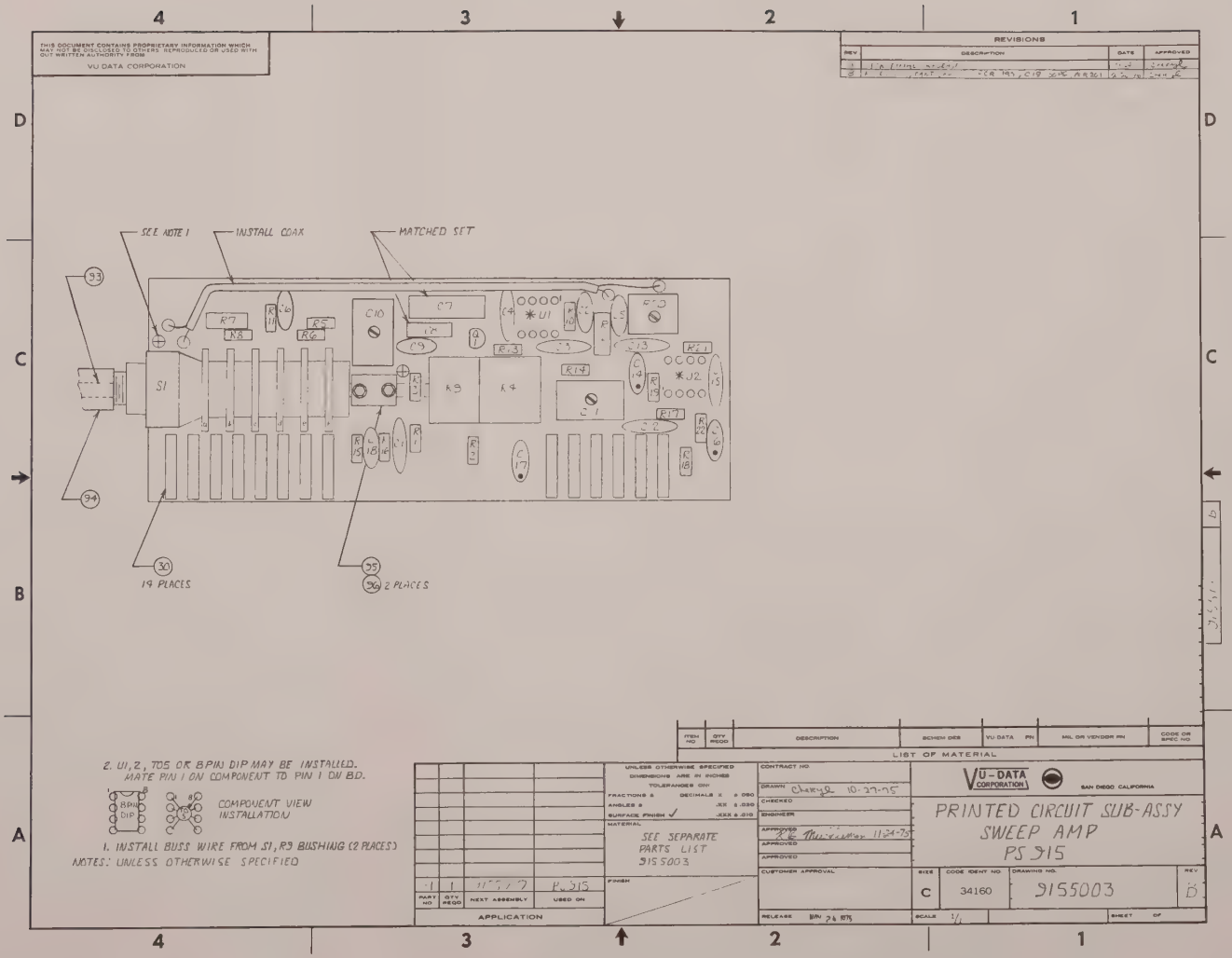

THIS DOCUMENT CONTAINS PROPRIETARY INFORMATION WHICH MAY NOT BE DISCLOSED TO OTHERS, REPRODUCED OR USED WITH OUT WRITTEN AUTHORITY FROM
VU DATA CORPORATION
REVISIONS
REV DESCRIPTION DATE APPROVED
SEE NOTE 1
INSTALL COAX
MATCHED SET
19 PLACES
2 PLACES
2. U1,2, TO5 OR 8PIN DIP MAY BE INSTALLED. MATE PIN 1 ON COMPONENT TO PIN 1 ON BD.
8PIN DIP
COMPONENT VIEW INSTALLATION
1. INSTALL BUSS WIRE FROM S1, R9 BUSHING (2 PLACES)
NOTES: UNLESS OTHERWISE SPECIFIED
LIST OF MATERIAL
ITEM NO QTY REQD DESCRIPTION SCHEM DES VU DATA PN MIL OR VENDOR PN CODE OR SPEC NO
SEE SEPARATE PARTS LIST 9155003
CONTRACT NO
DRAWN Cheryl 10-27-75
CHECKED
ENGINEER
APPROVED J.E. Thurston 11-24-75
APPROVED
APPROVED
CUSTOMER APPROVAL
VU-DATA CORPORATION SAN DIEGO CALIFORNIA
PRINTED CIRCUIT SUB-ASSY
SWEEP AMP
PS 915
SIZE C CODE IDENT NO 34160 DRAWING NO 9155003 REV B
SCALE 1/1 SHEET OF
PART NO QTY REQD NEXT ASSEMBLY USED ON
APPLICATION
RELEASE JAN 26 1976

Figure 5-6 Sweep Amp Sub-Assembly 9155003

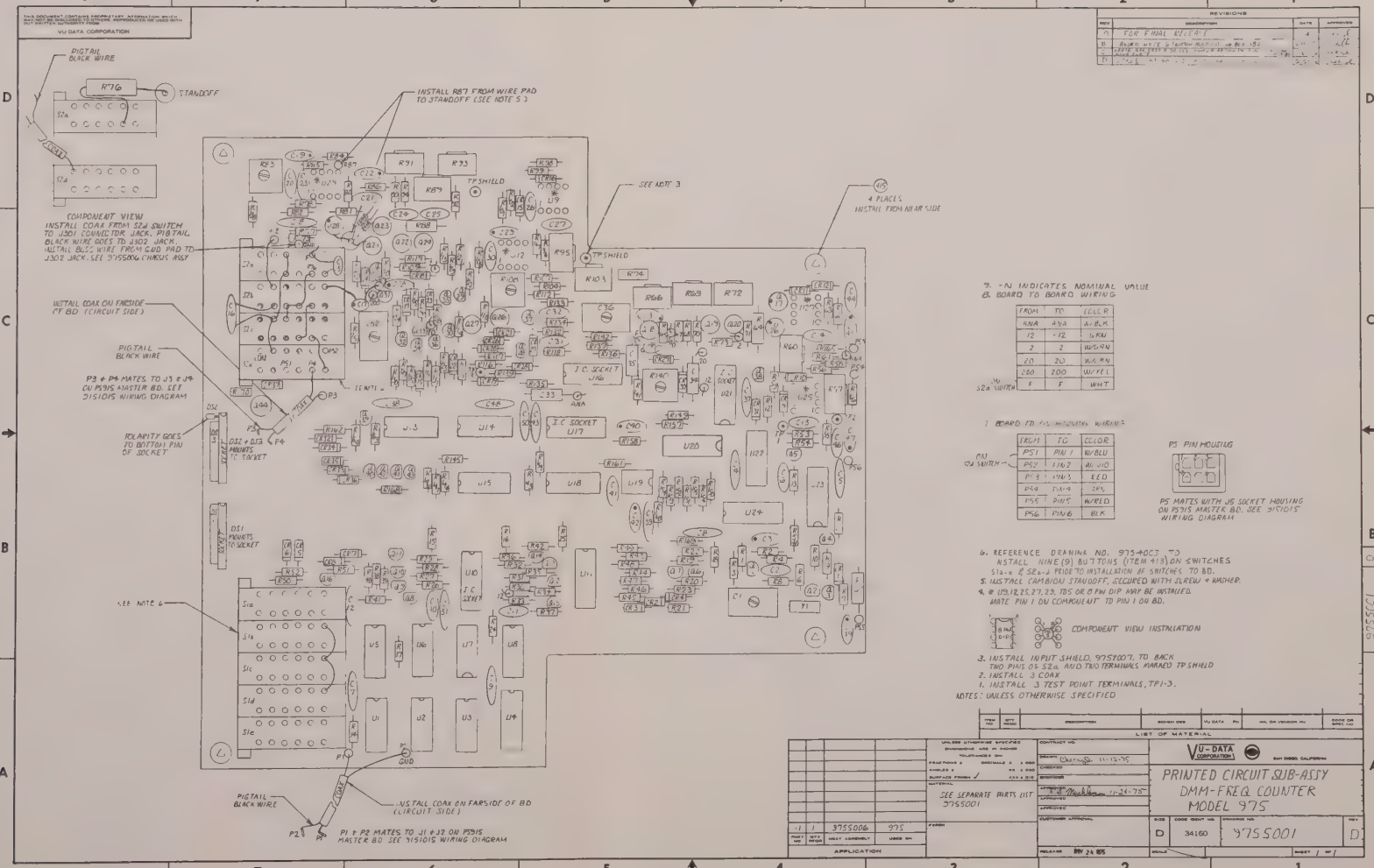

PIGTAIL BLACK WIRE
STANDOFF
COMPONENT VIEW
INSTALL COAX FROM S2a SWITCH TO J301 CONNECTOR JACK. PIGTAIL BLACK WIRE GOES TO J302 JACK. INSTALL BLK WIRE FROM GND PAD TO J302 JACK. SEE 9755006 CHASSIS ASSY
INSTALL COAX ON FARSIDE OF BD (CIRCUIT SIDE)
PIGTAIL BLACK WIRE
P3 & P4 MATES TO J3 & J4 ON PS915 MASTER BD. SEE 915015 WIRING DIAGRAM
POLARITY GOES TO BOTTOM PIN OF SOCKET
DS1 & DS3 MOUNTS TO SOCKET
DS1 MOUNTS TO SOCKET
SEE NOTE 6
INSTALL R87 FROM WIRE PAD TO STANDOFF (SEE NOTE 5)
TP SHIELD
SEE NOTE 3
4 PLACES INSTALL FROM REAR SIDE
I.C. SOCKET U16
I.C. SOCKET U17
PIGTAIL BLACK WIRE
INSTALL COAX ON FARSIDE OF BD (CIRCUIT SIDE)
P1 & P2 MATES TO J1 & J2 ON PS915 MASTER BD SEE 915015 WIRING DIAGRAM
9. -N INDICATES NOMINAL VALUE
8. BOARD TO BOARD WIRING
FROM TO COLOR
N/A A1A A.BLK
12 -12 GRN
2 2 WHT-GRN
20 20 YEL-GRN
200 200 WHT-YEL
F F WHT
J1 12A WIDTH
7. BOARD TO PS WIRING
FROM TO COLOR
P51 PIN 1 W/BLU
P52 PIN 2 W/GRN
P53 PIN 3 RED
P54 PIN 4 GRY
P55 PIN 5 W/RED
P56 PIN 6 BLK
J3 12A WIDTH
P5 PIN MOUNTING
P5 MATES WITH J5 SOCKET HOUSING ON PS915 MASTER BD. SEE 915015 WIRING DIAGRAM
6. REFERENCE DRAWING NO. 9754007 TO INSTALL NINE(9) BUTTONS (ITEM 413) ON SWITCHES S1a-e & S2a-d PRIOR TO INSTALLATION OF SWITCHES TO BD.
5. INSTALL CAMBION STANDOFF, SECURED WITH SCREW & WASHER.
4. U23,U24,25,27,29, TO5 OR 8 PIN DIP MAY BE INSTALLED. MATE PIN 1 ON COMPONENT TO PIN 1 ON BD.
COMPONENT VIEW INSTALLATION
3. INSTALL INPUT SHIELD, 9757007, TO BACK TWO PINS OF S2a AND TWO TERMINALS MARKED TP SHIELD
2. INSTALL 3 COAX
1. INSTALL 3 TEST POINT TERMINALS, TP1-3.
NOTES: UNLESS OTHERWISE SPECIFIED
REVISIONS
REV DESCRIPTION DATE APPROVED
A FOR FINAL RELEASE
LIST OF MATERIAL
SEE SEPARATE PARTS LIST 9755001
-1 1 9755006 975
APPLICATION
VU-DATA CORPORATION SAN DIEGO, CALIFORNIA
PRINTED CIRCUIT SUB-ASSY
DMM-FREQ COUNTER
MODEL 975
SIZE D CODE IDENT NO. 34160 DRAWING NO. 9755001 REV D
RELEASE NOV 24 1975 SCALE SHEET 1 OF 1
9755001

Figure 5-7 DMM/Frequency Counter Sub-Assembly 9755001

SECTION VI

PARTS LIST

Mfg. Code Number	Manufacturer	Location
00853	Sangamo	Marion, Illinois
01121	Allen Bradley	Milwaukee, Wisconsin
01294	Texas Instruments	Dallas, Texas
04062	Elmenco	New York, New York
04713	Motorola	Phoenix, Arizona
05397	Kemet	Cleveland, Ohio
07263	Fairchild	Mt. View, California
12406	Elpac	Fullerton, California
14099	Semtech Corp.	Newbury Park, California
14752	Electrocube	S. Pasadena, California
15818	Amelco	Mt. View, California
24931	Specialty Connector, Co., Inc.	Indianapolis, Indiana
26533	Zero	Burbank, California
27556	IMB	Santa Fe Springs, California
28520	Heyman Mfg., Co. (Heyco)	Kenilworth, New Jersey
34160	Vu-data Corp.	San Diego, California
44655	Ohmite Mfg., Co.	Skokie, Illinois
56289	Sprague	North Adams, Massachusetts
71450	CTS	Elkhart, Indiana
71590	Centralab	Milwaukee, Wisconsin
76055	Mallory	Frankfort, Indiana
78488	Stackpole	St. Mary's, Pennsylvania
78553	Tinnerman Products	Cleveland, Ohio
80368	Sylvania	New York, New York
81073	Grayhill	La Grange, Illinois
83330	H. H. Smith	Brooklyn, New York
84171	Arco	Great Neck, New York
86684	RCA	Harrison, New Jersey
87034	Marco-Oak	Anaheim, California
88245	Useco	Van Nuys, California
90201	Mallory	Indianapolis, Indiana
91637	Dale	Columbus, Nebraska
91662	Elco	Willow Grove, Pennsylvania
92219	Waldom	Chicago, Illinois
94222	Southco	Chester, Pennsylvania
95566	Arnold Eng.	Orange, California
99800	Delevan Electric Corp.	Aurora, New York

Table 6-1. Model PS915 Assemblies

TABLE	ASSEMBLY NUMBER	ASSEMBLY
6-3	9155008	Final Assembly
6-4	9155007	Chassis Assembly
6-5	9155006	Rear Panel Sub-Assembly
6-6	9155005	Front Panel Sub-Assembly
6-7	9155004	Vertical Switch Sub-Assembly
6-8	9155003	Sweep Amp Sub-Assembly
6-9	9155001	Master Board Sub-Assembly
6-10	9155016	Battery Pack Option Assembly

Table 6-2. Model 975 Assemblies

TABLE	ASSEMBLY NUMBER	ASSEMBLY
6-11	9755006	Chassis Assembly
6-12	9755001	Dmm/Freq Counter Sub-Assembly

Table 6-3. Parts List (Final Assembly 9155008)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
	9155007	Chassis Assy.	34160	
	9005016	Input Cable Assy.	34160	
	9152009	Bezel	34160	1-10721
	9152018	Bottom Panel	34160	1-10719
	9152020	Top Cover	34160	1-10718
2 Req.	9402094	Handle Support	34160	1-10694
2 Req.	9402095	Handle Arm	34160	1-10695
2 Req.	9402096	Handle Cover	34160	1-10696
	9402100	Handle Grip	34160	1-10698
	9402098	Handle Decal	34160	4-20236
	9152029	Bezel Decal	34160	4-20243
	9152036	Protective Hood	34160	4-20246
	9152040	Bottom Panel Decal	34160	4-20248
2 Req.	P312	Hole Plug	Heyco	
	SPH-386	Power Cord	Belden	2-70005
4 Req.	F4B	Cabinet Feet	Budwig	4-20037
2 Req.	LC-032D-1	Compression Spring - Music Wire	Lee Spring Co.	4-20237
2 Req.	AN500D-4-6	Screw, Fillister Hd., 4-40 X 3/8"		
2 Req.	MS24693-23	Screw, 100° Flathead, 6-32 X 3/16"		
4 Req.	MS51957-12	Screw, Panhead, 4-40 X 3/16"		
4 Req.	MS51958-63	Screw, Panhead, 10-32 X 1/2"		
4 Req.	MS24693-1	Screw, 100° Flathead, 4-40 X 3/16"		
4 Req.	MS24693-4	Screw, 100° Flathead, 4-40 X 3/8"		
2 Req.	Special-Car Steel	Screw, 100° Flathead, 6-32 X 11/16"		Black Oxide Treated
4 Req.	MS24693-47	Screw, 100° Flathead, 8-32 X 5/16"		
8 Req.	MS35333-70	Washer, Int. Lk., #4		
4 Req.	MS35338-43	Washer, Lk. Spring, #10		
4 Req.	NAS671C4	Nut, Plain Hex, 4-40		
2 Req.	22 Ft-632	Lock Nut, Thin Ht., 6-32	SPS	
		Shipping Container—PS915	34160	4-20253
		PS915/975 Manual	34160	4-20252

Table 6-3. Parts List (Final Assembly 9155008) (Continued)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
		When adding the Model 975 do the following:		
		DELETE		
P/L 9155008	9152020	Top Cover	34160	1-10718
P/L 9155001	RCR07G106JR	Res, CC, 10MΩ, ¼W, 5%	01121	5-10106
P/L 9155008	9152036	Protective Hood - PS915	34160	4-20246
		ADD		
	9755006	975 Chassis Assy.	34160	
	9752006	Top Cover	34160	1-10717
	9152049	Protective Hood—915/975	34160	4-20247
	1341	Test Leads, Needle	83330	4-20238
2 Req.	MS51957-13	Screw, Panhead, 4-40 X 1/4"		
2 Req.	MS35333-70	Washer, Int. Lk., #4		

Table 6-4. Parts List (Chassis Assembly 9155007)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
	9155005	Front Panel Sub-Assy.	34160	
1 Req.	9155006	Rear Panel Sub-Assy.	34160	
	9155001	Master Bd. Sub-Assy.	34160	
	9155003	Sweep Amp Sub-Assy.	34160	
	9152004	Crt. Shield	34160	1-10690
L401	9152007	Trace Angle Coil	34160	5-90009
	9152013	Angle Spacer—R.H.	34160	1-10706
	9152014	Angle Spacer—L.H.	34160	1-10705
2 Req.	9152015	Shield Mount	34160	1-10710
	9152019	Pot Holder	34160	1-10712
	9152024	Shaft Extender-Sweep	34160	1-10736
	9152025	Shaft-Intensity Pot	34160	
	9152026	Shaft-Focus Pot	34160	
	9152027	Shaft-Position Pot	34160	
	9152022	Knob Cap, X5 Magnifier	34160	4-10025
R403,S402	9152047	Res, Var, Car, 20KΩ, w/P-P SW.	34160	Make from: 5-78203
V401	D9-110GH	Cathode Ray Tube	Brimar	3-40006
4 Req.	021-220	Knob, Black, 1/8" Shaft, 10mm	Interlok	4-10011
2 Req.	021-123	Knob, Red, 1/8" Shaft, 9mm	Elma	4-10009
2 Req.	023-3520	Knob, Black, 1/4" Shaft, 14.5mm	Interlok	4-10013
2 Req.	044-2020	Nut Cover	Interlok	4-10019
2 Req.	040-1020	Knob Cap, Black	Interlok	4-10012
3 Req.	040-1030	Knob Cap, Red	Interlok	4-10010
	SB-250-2	SnapBushing, 1/4" Dia. Hole	Heyco	
3 Req.	DF-103C	Mica Insulator	86684	
3 Req.	DF-137A	Washer-Insulating	86684	
2 Req.	8700	Spacer #4 thru X 1/8"L	83330	4-20163
	8781	Spacer 4-40 X 13/16"L	83330	4-20245
4 Req.	9402084	Shaft Coupler	34160	1-10699
	N-440-¼ Binder Hd-Blk	Screw, Binder Hd, 4-40 X 1/4", Black Nylon		
8 Req.	MS51963-9	Set Screw, Allen Head, 4-40 X 1/8"		

Table 6-4. Parts List (Chassis Assembly 9155007) (Continued)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
A/R		Foam, Self-Adhesive 1/4" X 3/8"		
A/R		Spring, Music Wire, .125 O.D., .016 Dia.	Century	
2 Req.	MS51957-12	Screw, Panhead, 4-40 X 3/16"		
9 Req.	MS51957-13	Screw, Panhead, 4-40 X 1/4"		
2 Req.	MS24693-1	Screw, 100° Flathead, 4-40 X 3/16"		
4 Req.	MS24693-2	Screw, 100° Flathead, 4-40 X 1/4"		
2 Req.	MS24693-4	Screw, 100° Flathead, 4-40 X 3/8"		
9 Req.	MS35333-70	Washer, Int. Lk., #4		
2 Req.	NAS671C4	Nut, Plain Hex, 4-40		

Table 6-5. Parts List (Rear Panel Sub-Assembly 9155006)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
	9152016	Sub Rear Panel	34160	1-10714
	9152017	Rear Panel	34160	1-10713
T501	9152005	Power Transformer	34160	7-61019
R501	9152034	Trace Angle Pot, 50KΩ	34160	5-72110
R502	9152035	Astigmatism Pot, 250KΩ	34160	5-72111
4 Req.	9152037	T.F. Foot	34160	1-10724
J501,XF501, S501	6J1	Voltage Selector and Fused Connector	Corcom	2-40015
S502	7203 W/J Rocker	Switch, DP TT	C&K	2-10031
Q501	D44H2	NPN, Power	GE	3-24442
F501*	313.500	3AG S.B. Fuse, ½A	Littlefuse	2-40017
F501*	313.250	3AG S.B. Fuse, ¼A	Littlefuse	2-40004
	UP-T066B	Heatsink	IERC	3-90001
	DF-103C	Mica Insulator	86684	
	DF-137A	Washer, Insulating	86684	
2 Req.	2374	Spacer, 4-40 X 1"	83330	4-20161
4 Req.	F4B	Cabinet Feet	Budwig	4-20037
2 Req.	OCB-375	Open-Closed Bushing	Heyco	
2 Req.	MS51957-20	Screw, Panhead, 4-40 X 7/8"		
2 Req.	9152044	Screw, Panhead, 4-40 X 1.350"	34160	1-10737
6 Req.	MS51957-15	Screw, Panhead, 4-40 X 3/8"		
2 Req.	MS51957-23	Screw, Panhead, 4-40 X 1-1/2"		
8 Req.	NAS620C4	Washer, Flat, #4		
12 Req.	MS35333-70	Washer, Int. Lk., #4		
2 Req.	NAS671C4	Nut, Plain, 4-40		

*For 115V operation use ½A; 230V use ¼A.

Table 6-6. Parts List (Front Panel Sub-Assembly 9155005)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
	9155004	Vertical Switch Sub-Assy.	34160	
	9152010	Front Panel	34160	1-10722
	9152011	Front Mech Support	34160	1-10709
	9152012	Top Support	34160	1-10711
	9152045	Graticule	34160	2-60007
DS401	XC209G	Indicator Light, Green	Xciton	3-10210
R401	RCR07G470JR	Res, CC, 47Ω, ¼W, 5%	01121	5-10470
R402,S401	9152048	Trigger Level Pot—50KΩ	34160	Make from: 5-78555
R405	WA4G028S253MA	Res, Var, Car, 25KΩ	01121	5-79600
J401	UG1094/U	BNC Connector		2-28998
J402	UG1094/U	BNC Connector		2-28998
J403	63-1000-101	Test Jack-White	83330	2-50009
2 Req.	1497	Solder Lug	83330	4-20147
2 Req.	184	Panel Bearing, 1/8" Shaft	83330	4-20120
2 Req.	MS35333-74	Washer, Int. Lk., 1/4"		
2 Req.	MS24693-2	Screw, 100° Flathead, 4-40 X 1/4"		

Table 6-7. Parts List (Vertical Switch Sub-Assembly 9155004)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
S601	9402029	Vertical Switch	34160	2-10036
		CAPACITORS		
C601	5HK-D50	CD, .005μF GMV, 1KV	56289	6-29502
C602	PC400	Var, Mica, .9–7pF	84171	6-96000
C603	C4002/1B	Var, Mica, 2–20pF	84171	6-96005
C604	DM15-331J	DM, 330pF ±5%, 500V	04062	6-19331
		RESISTORS		
R601	RCR20G1R0JR	CC, 1Ω, 1/2W, 5%	01121	5-20010
R602	RCR07G100JR	CC, 10Ω, 1/4", 5%	01121	5-10100
R603	RCR07G104JR	CC, 100KΩ, 1/4W, 5%	01121	5-10104
R604	RN65D1104F	MF, 1.10MΩ, 1/4W, 1%	91637	5-52494
R605	RN65D1104F	MF, 1.10MΩ, 1/4W, 1%	91637	5-52494
R606	RN55D1132F	MF, 11.3KΩ, 1/8W, 1%	91637	5-51304
R607	RCR07G470JR	CC, 47Ω, 1/4W, 5%	01121	5-10470
R608	RCR07G100JR	CC, 10Ω, 1/4W, 5%	01121	5-10100
R609	RN55D6650F	MF, 665Ω, 1/8W, 1%	91637	5-51175
R610	RN55D4020F	MF, 402Ω, 1/8W, 1%	91637	5-51154
R611	RN55D1330F	MF, 133Ω, 1/8W, 1%	91637	5-51108
R612	RN55D66R5F	MF, 66.5Ω, 1/8W, 1%	91637	5-51079
R613	RN55D40R2F	MF, 40.2Ω, 1/8W, 1%	91637	5-51058
R614	RN55D26R7F	MF, 26.7Ω, 1/8W, 1%	91637	5-51041
R615	PART OF S601	Var, Car, 1KΩ	34160	See 2-10036
R616	RN55D6190F	MF, 619Ω, 1/8W, 1%	91637	5-51172
L601	.115 X .125	Ferrite Bead	Amidon	5-90001

Table 6-8. Parts List (Sweep Amp Sub-Assembly 9155003)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
	9153003	Etched Circuit Bd.	34160	1-20087
		CAPACITORS		
C1	UK20-104	CD, .1μF + 80%–20%, 20V	71590	6-24104
C2	DM15-220J	DM, 22pF ±5%, 500V	04062	6-19220
C3	CK-104	CD, .1μF ±20%, 50V	71590	6-26104
C4	UK20-104	CD, .1μF + 80%–20%, 20V	71590	6-24104
C5	DM15-020D	DM, 2pF ±.5pF, 500V	04062	6-19020
C6	DM15-050D	DM, 5pF ±.5pF, 500V	04062	6-19050
C7	9002070	MM, 1μF, 50V } Matched	34160	6-56003
C8		MM, .01μF, 50V } Set		
C9	DM15-820J	DM, 82pF ±5%, 500V	04062	6-19820
C10	C4002/1B	Var, Mica, 2–20pF	84171	6-96005
C11	C4003/1B	Var, Mica, 4–45pF	84171	6-96004
C12	UK20-104	CD, .1μF + 80%–20%, 20V	71590	6-24104
C13	UK20-104	CD, .1μF + 80%–20%, 20V	71590	6-24104
C14	T362C686M015AS	TANT, 68μF ±20%, 15V	05397	6-73686
C15	UK20-104	CD, .1μF + 80%–20%, 20V	71590	6-24104
C16	T362C686M015AS	TANT, 68μF ±20%, 15V	05397	6-73686
C17	T362D227M010AS	TANT, 220μF ±20%, 10V	05397	6-76227
C18	DM15-101J	DM, 100pf ±5%, 500V	04062	6-19101
14 Req.	02-014-013-5-200	Elco Pin, 1/16" Card	Elco	2-29994
		INTEGRATED CIRCUITS		
U1	LM318	OP, Amp	Nat'l	3-30318
U2	LM318	OP, Amp	Nat'l	3-30318
		RESISTORS		
R1	RN55D2002F	MF, 20.0KΩ, 1/8W, 1%	91637	5-51328
R2	RN55D2002F	MF, 20.0KΩ, 1/8W, 1%	91637	5-51328
R3	RN55D2491F	MF, 2.49KΩ, 1/8W, 1%	91637	5-51231
R4	2432001-7	Dual Mod Pot, 25KΩ ±10%	34160	5-79253
R5	RN55D1053F	MF, 105KΩ, 1/8W, 1%	91637	5-51396
R6	RN55D1052F	MF, 10.5KΩ, 1/8W, 1%	91637	5-51301
R7	RN60D9533F	MF, 953KΩ, 1/4W, 1%	91637	5-50488
R8	RN55D9532F	MF, 95.3KΩ, 1/8W, 1%	91637	5-51392
R9	See R4	Car, 25KΩ ±10%	34160	See R4
R10	RCR07G822JR	CC, 8.2KΩ, 1/4W, 5%	01121	5-10822
R11	RN55D2102F	MF, 21.0KΩ, 1/8W, 1%	91637	5-51330
R12	RN60D1004F	MF, 1MΩ, 1/4W, 1%	91637	5-50490
R13	RCR07G332JR	CC, 3.3KΩ, 1/4W, 5%	01121	5-10332
R14	RN55D1003F	MF, 100KΩ, 1/8W, 1%	91637	5-51394
R15	RN55D1001F	MF, 1.00KΩ, 1/8W, 1%	91637	5-51193

Table 6-8. Parts List (Sweep Amp Sub-Assembly 9155003) (Continued)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
R16	RN55D9091F	MF, 9.09KΩ, 1/8W, 1%	91637	5-51295
R17	RN55D1003F	MF, 100KΩ, 1/8W, 1%	91637	5-51394
R18	RCR07G101JR	CC, 100Ω, 1/4W, 5%	01121	5-10101
R19	RCR07G823JR	CC, 82KΩ, 1/4W, 5%	01121	5-10823
R20	360T253B	Var, Cer, 25KΩ	71450	5-73253
R21	RCR07G150JR	CC, 15Ω, 1/4W, 5%	01121	5-10150
R22	RCR07G150JR	CC, 15Ω, 1/4W, 5%	01121	5-10150
S1	9152001	Sweep Switch	34160	2-10045
Q1	F2762	Fet, N, Ch	Solitron	3-22762
		MISCELLANEOUS		
	9152028	Shaft—Concentric Sweep	34160	
	120	Coupler, Shaft, 1/4"	83330	4-20204
	9402084	Shaft Coupler	34160	1-10699
2 Req.	MS51963-9	Set Screw, Allen Head, 4-40 X 1/8"		

Table 6-9. Parts List (Master Board Sub-Assembly 9155001)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
	9153001	Etched Circuit Bd.	34160	1-20086
		CAPACITORS		
C1	5HK-P10	CD, .1μF +80%—20%, 500V	56289	6-29103
C2	UK20-104	CD, .1μF + 80%—20%, 20V	71590	6-24104
C3	DM15-181J	DM, 180pF ±5%, 500V	04062	6-19181
C4	UK20-104	CD, .1μF + 80%—20%, 20V	71590	6-24104
C5	UK20-104	CD, .1μF + 80%—20%, 20V	71590	6-24104
C6	UK20-104	CD, .1μF + 80%—20%, 20V	71590	6-24104
C7	DM15-020D	DM, 2pF ±.5pF, 500V	04062	6-19020
C8	DM15-050D	DM, 5pF ±.5pF, 500V	04062	6-19050
C9	T362B106M020AS	TANT, 10μF ±20%, 20V	05397	6-71106
C10	T362B106M020AS	TANT, 10μF ±20%, 20V	05397	6-71106
C11	UK20-104	CD, .1μF + 80%—20%, 20V	71590	6-24104
C12	UK25-223	CD, .022μF ±20%, 25V	71590	6-24203
C13	5GA-D20	CD, 2000pF ±20%, 1KV	56289	6-20202
C14	UK20-104	CD, .1μF + 80%—20%, 20V	71590	6-24104
C15	DM15-100J	DM, 10pF ±5%, 500V	04062	6-19100
C16	DM15-330J	DM, 33pF ±5%, 500V	04062	6-19330
C17	UK20-104	CD, .1μF + 80%—20%, 20V	71590	6-24104
C18	UK20-104	CD, .1μF + 80%—20%, 20V	71590	6-24104
C19	DM15-330J	DM, 33pF ±5%, 500V	04062	6-19330
C20	DM15-300J	DM, 30pF ±5%, 500V	04062	6-19300
C21	DM15-121J	DM, 120pF ±5%, 500V	04062	6-19121
C22	5HK-D50	CD, .005μF GMV, 1KV	56289	6-29502
C23	UK20-104	CD, .1μF + 80%—20%, 20V	71590	6-24104
C24	UK20-104	CD, .1μF + 80%—20%, 20V	71590	6-24104
C25	UK20-104	CD, .1μF + 80%—20%, 20V	71590	6-24104
C26	DM15-150J	DM, 15pF ±5%, 500V	04062	6-19150
C27	UK20-104	CD, .1μF + 80%—20%, 20V	71590	6-24104
C28	DC-104	CD, .1μF ±20%, 100V	71590	6-27107
C29	DC-104	CD, .1μF ±20%, 100V	71590	6-27107
C30	CK-104	CD, .1μF ±20%, 50V	71590	6-26104
C31	DDM-103	CD, .01μF +60—40%, 150V	71590	6-27103
C32	DDM-103	CD, .01μF +60—40%, 150V	71590	6-27103
C33	CK-104	CD, .1μF ±20%, 50V	71590	6-26104
C34	T362C106M035AS	TANT, 10μF ±20%, 35V	05397	6-75106
C35	DDM-103	CD, .01μF +60—40%, 150V	71590	6-27103
C36	DDM-103	CD, .01μF +60—40%, 150V	71590	6-27103
C37	CK-104	CD, .1μF ±20%, 50V	71590	6-26104
C38	DC-104	CD, .1μF ±20%, 100V	71590	6-27107
C39	DC-104	CD, .1μF ±20%, 100V	71590	6-27107
C40	UK20-104	CD, .1μF + 80%—20%, 20V	71590	6-24104

Table 6-9. Parts List (Master Board Sub-Assembly 9155001) (Continued)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
C41	DM15-680J	DM, 68pF ±5%, 500V	04062	6-19680
C42	DM15-100J	DM, 10pF ±5%, 500V	04062	6-19100
C43	UK20-104	CD, .1μF + 80%–20%, 20V	71590	6-24104
C44	UK20-104	CD, .1μF + 80%–20%, 20V	71590	6-24104
C45	UK20-104	CD, .1μF + 80%–20%, 20V	71590	6-24104
C46	5GA-D10	CD, .001μF ±20%, 1KV	56289	6-20102
C47	UK20-104	CD, .1μF + 80%–20%, 20V	71590	6-24104
C48	UK20-104	CD, .1μF + 80%–20%, 20V	71590	6-24104
C49	UK20-104	CD, .1μF + 80%–20%, 20V	71590	6-24104
C50	UK20-104	CD, .1μF + 80%–20%, 20V	71590	6-24104
C51	T362D107M020AS	TANT, 100μF ±20%, 20V	05397	6-74107
C52	T362D107M020AS	TANT, 100μF ±20%, 20V	05397	6-74107
C53	UK20-104	CD, .1μF + 80%–20%, 20V	71590	6-24104
C54	T362B475M020AS	TANT, 4.7μF ±20%, 20V	05397	6-74475
C55	T362B475M020AS	TANT, 4.7μF ±20%, 20V	05397	6-74475
C56	DM15-101J	DM, 100pF ±5%, 500V	04062	6-19101
C57	UK20-104	CD, .1μF + 80%–20%, 20V	71590	6-24104
C58	UK20-104	CD, .1μF + 80%–20%, 20V	71590	6-24104
C59	UK20-104	CD, .1μF + 80%–20%, 20V	71590	6-24104
C60	UK20-104	CD, .1μF + 80%–20%, 20V	71590	6-24104
C61	UK20-104	CD, .1μF + 80%–20%, 20V	71590	6-24104
C62	UK20-104	CD, .1μF + 80%–20%, 20V	71590	6-24104
C63	UK20-104	CD, .1μF + 80%–20%, 20V	71590	6-24104
C64	T362C686M015AS	TANT, 68μF ±20%, 15V	05397	6-73686
C65	T362C686M015AS	TANT, 68μF ±20%, 15V	05397	6-73686
C66	T362B686M006AS	TANT, 68μF ±20%, 6V	05397	6-71686
C67	DM15-820J	DM, 82pF ±5%, 500V	04062	6-19820
C68	T362C106M035AS	TANT, 10μF ±20%, 35V	05397	6-75106
C69	CK-104	CD, .1μF ±20%, 50V	71590	6-26104
C70	T362C106M035AS	TANT, 10μF ±20%, 35V	05397	6-75106
C71	CK-104	CD, .1μF ±20%, 50V	71590	6-26104
C72	DDM-103	CD, .01μF +60–40%, 150V	71590	6-27103
C73	DDM-103	CD, .01μF +60–40%, 150V	71590	6-27103
C74	CK-104	CD, .1μF ±20%, 50V	71590	6-26104
C75	UK20-104	CD, .1μF + 80%–20%, 20V	71590	6-24104
C76	UK20-104	CD, .1μF + 80%–20%, 20V	71590	6-24104
C77	DDM-103	CD, .01μF +60–40%, 150V	71590	6-27103
C78	DDM-103	CD, .01μF +60–40%, 150V	71590	6-27103
C79	T362C106M035AS	TANT, 10μF ±20%, 35V	05397	6-75106
C80	CK-104	CD, .1μF ±20%, 50V	71590	6-26104
C81	T362C106M035AS	TANT, 10μF ±20%, 35V	05397	6-75106
C82-N	DM15-150J	DM, 15pF ±5%, 500V	04062	6-19150
C83	UK20-104	CD, .1μF + 80%–20%, 20V	71590	6-24104

*All – N references indicate nominal value.

Table 6-9. Parts List (Master Board Sub-Assembly 9155001) (Continued)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
C84	UK20-104	CD, .1μF + 80%—20%, 20V	71590	6-24104
C85	UK20-104	CD, .1μF + 80%—20%, 20V	71590	6-24104
C86	T362D227M010AS	TANT, 220μF ±20%, 10V	05397	6-76227
C87	T362D227M010AS	TANT, 220μF ±20%, 10V	05397	6-76227
C88	672D567H020DS2C	Elect, 560μF, 20V	56289	6-83567
C89	672D567H020DS2C	Elect, 560μF, 20V	56289	6-83567
C90	672D567H020DS2C	Elect, 560μF, 20V	56289	6-83567
C91	672D567H020DS2C	Elect, 560μF, 20V	56289	6-83567
C92	5HK-S50	CD, .05μF ±20%, 500V	56289	6-29045
C93	5GA-D10	CD, .001μF ±20%, 1KV	56289	6-20102
C94	T362C336M020AS	TANT, 33μF ±20%, 20V	05397	6-74336
C95	T362D227M010AS	TANT, 220μF ±20%, 10V	05397	6-76227
C96	T362D227M010AS	TANT, 220μF ±20%, 10V	05397	6-76227
C97	UK20-104	CD, .1μF + 80%—20%, 20V	71590	6-24104
C98	UK20-104	CD, .1μF + 80%—20%, 20V	71590	6-24104
C99	5HK-D50	CD, .005μF GMV, 1KV	56289	6-29502
C100	T362D476M035AS	TANT, 47μF ±20%, 35V	05397	6-75476
C101	DDM-103	CD, .01μF +60—40%, 150V	71590	6-27103
C102	DM15-471J	DM, 470pF ±5%, 500V	04062	6-19471
C103	DM15-471J	DM, 470pF ±5%, 500V	04062	6-19471
C104	XA2A103J	MM, .01μF ±5%, 50V	27556	6-46103
C105	UK20-104	CD, .1μF + 80%—20%, 20V	71590	6-24104
C106	T362C686M015AS	TANT, 68μF ±20%, 15V	05397	6-73686
C107	5HK-D50	CD, .005μF GMV, 1KV	56289	6-29502
C108	DM15-220J	DM, 22pF ±5%, 500V	04062	6-19220
C109	DM15-220J	DM, 22pF ±5%, 500V	04062	6-19220
C110	UK20-104	CD, .1μF + 80%—20%, 20V	71590	6-24104
C111	30GA-Q22	CD, 22pF ±20%, 3KV	56289	6-20220
C112	30GA-Q22	CD, 22pF ±20%, 3KV	56289	6-20220
C113	30GA-D50	CD, .005μF ±20%, 3KV	56289	6-20502
C114	DM15-050D	DM, 5pF ±.5pF, 500V	04062	6-19050
C115	DM15-050D	DM, 5pF ±.5pF, 500V	04062	6-19050
C116	DC-104	CD, .1μF ±20%, 100V	71590	6-27107
C117	DM15-050D	DM, 5pF ±.5pF, 500V	04062	6-19050
C118	DM15-050D	DM, 5pF ±.5pF, 500V	04062	6-19050
C119	DC-104	CD, .1μF ±20%, 100V	71590	6-27107
C120	T362B475M050AS	TANT, 4.7μF ±20%, 50V	05397	6-76475
C121	DC-104	CD, .1μF ±20%, 100V	71590	6-27107
C122	30GA-S10	CD, .01μF ±20%, 3KV	56289	6-29104
C123	T362B475M050AS	TANT, 4.7μF ±20%, 50V	05397	6-76475
C124	T362B475M050AS	TANT, 4.7μF ±20%, 50V	05397	6-76475
C125	DC-104	CD, .1μF ±20%, 100V	71590	6-27107
C126	UK20-104	CD, .1μF + 80%—20%, 20V	71590	6-24104

Table 6-9. Parts List (Master Board Sub-Assembly 9155001) (Continued)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
C127	T362D337M006AS	TANT, 330μF ±20%, 6V	05397	6-71337
C128	UK20-104	CD, .1μF + 80%–20%, 20V	71590	6-24104
C129	T362D227M010AS	TANT, 220μF ±20%, 10V	05397	6-76227
C130	UK20-104	CD, .1μF + 80%–20%, 20V	71590	6-24104
C131	T362D227M010AS	TANT, 220μF ±20%, 10V	05397	6-76227
C132	CK-104	CD, .1μF ±20%, 50V	71590	6-26104
C133	T362D476M035AS	TANT, 47μF ±20%, 35V	05397	6-75476
C134	CK-104	CD, .1μF ±20%, 50V	71590	6-26104
C135	T362D476M035AS	TANT, 47μF ±20%, 35V	05397	6-75476
C136	UK20-104	CD, .1μF + 80%–20%, 20V	71590	6-24104
C137	T362D107M020AS	TANT, 100μF ±20%, 20V	05397	6-74107
C138	UK20-104	CD, .1μF + 80%–20%, 20V	71590	6-24104
C139	T362D107M020AS	TANT, 100μF ±20%, 20V	05397	6-74107
C140	DC-104	CD, .1μF ±20%, 100V	71590	6-27107
C141	672D276H100DM2C	Elect, 27μF, 100V	56289	6-87276
C142	DC-104	CD, .1μF ±20%, 100V	71590	6-27107
C143	672D276H100DM2C	Elect, 27μF,100V	56289	6-87276
C144	T362B475M050AS	TANT, 4.7μF ±20%, 50V	05397	6-76475
C145	5GA-S10	CD, .01μF ±20%, 1KV	56289	6-29053
C146	5GA-S10	CD, .01μF ±20%, 1KV	56289	6-29053
C147	5GA-S10	CD, .01μF ±20%, 1KV	56289	6-29053
C148	30GA-S10	CD, .01μF ±20%, 3KV	56289	6-29104
C149	5GA-S10	CD, .01μF ±20%, 1KV	56289	6-29053
C150	T362C106M035AS	TANT, 10μF ±20%, 35V	05397	6-75106
C151	BA2E104K	MM, .1μF ±10%, 400V	27556	6-59104
C152*	30GA-T39	CD, 390pF ±20%, 3KV	56289	6-29391
C153	5GA-D10	CD, .001μF ±20%, 1KV	56289	6-20102
C154-N	DM15-391	DM, 390pF ±5%, 500V	04062	6-19391
		CONNECTORS		
J1–4	450-3366-01-03	Jack, Connector	Cambion	2-24014
J5	1-480270-0	Housing, Socket	Amp	
J5, (1–6)	61173-1	Socket	Amp	
J6, 7	S0-440-8	Standoff, 4-40 Captive, 1/4" L	46384	
L1	.115 X .125	Ferrite Bead	Amidon	5-90001
L2	.115 X .125	Ferrite Bead	Amidon	5-90001
L3	.115 X .125	Ferrite Bead	Amidon	5-90001
L4	.115 X .125	Ferrite Bead	Amidon	5-90001

*Not shown on drawing. Goes on CRT socket.

Table 6-9. Parts List (Master Board Sub-Assembly 9155001) (Continued)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
		DIODES		
CR1	1N914	GP, Signal	07263	3-10914
CR2	1N914	GP, Signal	07263	3-10914
CR3	1N914	GP, Signal	07263	3-10914
CR4	1N914	GP, Signal	07263	3-10914
CR5	1N914	GP, Signal	07263	3-10914
CR6	1N914	GP, Signal	07263	3-10914
CR7	1N914	GP, Signal	07263	3-10914
CR8	1N914	GP, Signal	07263	3-10914
CR9	1N914	GP, Signal	07263	3-10914
CR10	1N914	GP, Signal	07263	3-10914
CR11	1N914	GP, Signal	07263	3-10914
CR12	1N914	GP, Signal	07263	3-10914
CR13	1N914	GP, Signal	07263	3-10914
CR14	1N914	GP, Signal	07263	3-10914
CR15	1N914	GP, Signal	07263	3-10914
CR16	5082-2800	Schottky	H.P.	3-12800
CR17	1N914	GP, Signal	07263	3-10914
CR18	1N914	GP, Signal	07263	3-10914
CR19	1N914	GP, Signal	07263	3-10914
CR20	1N914	GP, Signal	07263	3-10914
CR21	1N914	GP, Signal	07263	3-10914
CR22	1N914	GP, Signal	07263	3-10914
CR23	1N914	GP, Signal	07263	3-10914
CR24	1N914	GP, Signal	07263	3-10914
CR25	1N914	GP, Signal	07263	3-10914
CR26	1N914	GP, Signal	07263	3-10914
CR27	1N914	GP, Signal	07263	3-10914
CR28	FD300	Low Leakage	07263	3-10300
CR29	FD300	Low Leakage	07263	3-10300
CR30	1N914	GP, Signal	07263	3-10914
CR31	1N914	GP, Signal	07263	3-10914
CR32	1N914	GP, Signal	07263	3-10914
CR33	1N914	GP, Signal	07263	3-10914
CR34	1N914	GP, Signal	07263	3-10914
CR35	1N914	GP, Signal	07263	3-10914
CR36	1N914	GP, Signal	07263	3-10914
CR37	1N914	GP, Signal	07263	3-10914
CR38	1N914	GP, Signal	07263	3-10914
CR39	1N914	GP, Signal	07263	3-10914
CR40	MR501	Power, 3A, 100V	04713	3-10501
CR41	MR501	Power, 3A, 100V	04713	3-10501
CR42	MR501	Power, 3A, 100V	04713	3-10501

Table 6-9. Parts List (Master Board Sub-Assembly 9155001) (Continued)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
CR43	1N4004	Power, 1A, 400V	07263	3-14004
CR44	1N4004	Power, 1A, 400V	07263	3-14004
CR45	1N914	GP, Signal	07263	3-10914
CR46	1N914	GP, Signal	07263	3-10914
CR47	1N914	GP, Signal	07263	3-10914
CR48	1N914	GP, Signal	07263	3-10914
CR49	1N5232A	Zener, 5.6V	04713	3-15232
CR50	1N914	GP, Signal	07263	3-10914
CR51	1N914	GP, Signal	07263	3-10914
CR52	1N4004	Power, 1A, 400V	07263	3-14004
CR53	1N4004	Power, 1A, 400V	07263	3-14004
CR54	1N4004	Power, 1A, 400V	07263	3-14004
CR55	1N914	GP, Signal	07263	3-10914
CR56	1N4004	Power, 1A, 400V	07263	3-14004
CR57	1N750	Zener, 4.7V	04713	3-10750
CR58	1N914	GP, Signal	07263	3-10914
CR59	1N914	GP, Signal	07263	3-10914
CR60	1N914	GP, Signal	07263	3-10914
CR61	1N914	GP, Signal	07263	3-10914
CR62	1N4004	Power, 1A, 400V	07263	3-14004
CR63	1N914	GP, Signal	07263	3-10914
CR64-N	1N965B	Zener, 15V	04713	3-10965
CR65	1N4004	Power, 1A, 400V	07263	3-14004
CR66	1N4004	Power, 1A, 400V	07263	3-14004
CR67	1N4004	Power, 1A, 400V	07263	3-14004
CR68	1N4004	Power, 1A, 400V	07263	3-14004
CR69	1N4004	Power, 1A, 400V	07263	3-14004
CR70	1N4004	Power, 1A, 400V	07263	3-14004
CR71	1N4004	Power, 1A, 400V	07263	3-14004
CR72	1N4004	Power, 1A, 400V	07263	3-14004
CR73	1N4004	Power, 1A, 400V	07263	3-14004
CR74	1N4004	Power, 1A, 400V	07263	3-14004
CR75	1N4004	Power, 1A, 400V	07263	3-14004
CR76	1N4004	Power, 1A, 400V	07263	3-14004
CR77	1N4004	Power, 1A, 400V	07263	3-14004
CR78	1N4004	Power, 1A, 400V	07263	3-14004
CR79	1N4004	Power, 1A, 400V	07263	3-14004
CR80	1N4004	Power, 1A, 400V	07263	3-14004
CR81	1N4004	Power, 1A, 400V	07263	3-14004
CR82	1N4004	Power, 1A, 400V	07263	3-14004
CR83	1N4004	Power, 1A, 400V	07263	3-14004
CR84	1N4004	Power, 1A, 400V	07263	3-14004
CR85	1N4004	Power, 1A, 400V	07263	3-14004

Table 6-9. Parts List (Master Board Sub-Assembly 9155001) (Continued)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
CR86	1N4004	Power, 1A, 400V	07263	3-14004
CR87	1N4004	Power, 1A, 400V	07263	3-14004
CR88	1N4004	Power, 1A, 400V	07263	3-14004
CR89	SCM40	Rectifier	14099	3-10350
CR90	SCM40	Rectifier	14099	3-10350
CR91	SCM40	Rectifier	14099	3-10350
CR92	SCM40	Rectifier	14099	3-10350
CR93	1N914	GP, Signal	07263	3-10914
CR94	1N914	GP, Signal	07263	3-10914
CR95	1N914	GP, Signal	07263	3-10914
CR96	1N914	GP, Signal	07263	3-10914
CR97	1N914	GP, Signal	07263	3-10914
CR98	1N914	GP, Signal	07263	3-10914
CR99	1N914	GP, Signal	07263	3-10914
CR100	1N914	GP, Signal	07263	3-10914
		ELCO PINS		
14 Req.	02-014-113-3-200	Elco Pin, 1/16" Card	Elco	2-29993
F1	315 002	Fuse, Type 3AG Slo Blo, Pigtail, 2A	Littlefuse	2-40016
		INTEGRATED CIRCUITS		
U1	MC1710CG	Comp, 710	04713	3-30710
U2	FD1753	Dual Fet, "N" Ch	Solitron	3-21753
U3	LM318	OP, Amp	Nat'l	3-30318
U4	733HC	OP, Amp	04713	3-30733
U5	LM301	OP, Amp	Nat'l	3-30301
U6	MCT2E	Optical Coupler	Monsanto	3-10102
U7	LM301	OP, Amp	Nat'l	3-30301
U8	MPQ3904	Quad Transistor Array	04713	3-33904
		RESISTORS		
R1	RCR07G563JR	CC, 56KΩ, 1/4W, 5%	01121	5-10563
R2	RCR07G104JR	CC, 100KΩ, 1/4W, 5%	01121	5-10104
R3	RN60D1004F	MF, 1MΩ, 1/4W, 1%	91637	5-50490
R4	RCR07G104JR	CC, 100KΩ, 1/4W, 5%	01121	5-10104
R5	RCR07G181JR	CC, 180Ω, 1/4W, 5%	01121	5-10181
R6	RCR07G472JR	CC, 4.7KΩ, 1/4W, 5%	01121	5-10472
R7	RCR07G683JR	CC, 68KΩ, 1/4W, 5%	01121	5-10683
R8	RCR07G181JR	CC, 180Ω, 1/4W, 5%	01121	5-10181
R9	RCR07G472JR	CC, 4.7KΩ, 1/4W, 5%	01121	5-10472
R10	RCR07G683JR	CC, 68KΩ, 1/4W, 5%	01121	5-10683

Table 6-9. Parts List (Master Board Sub-Assembly 9155001) (Continued)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
R11	RCR07G181JR	CC, 180Ω, 1/4W, 5%	01121	5-10181
R12	RCR07G103JR	CC, 10KΩ, 1/4W, 5%	01121	5-10103
R13	RCR07G391JR	CC, 390Ω, 1/4W, 5%	01121	5-10391
R14	RCR07G181JR	CC, 180Ω, 1/4W, 5%	01121	5-10181
R15	RCR07G103JR	CC, 10KΩ, 1/4W, 5%	01121	5-10103
R16	RCR07G220JR	CC, 22Ω, 1/4W, 5%	01121	5-10220
R17	RCR07G220JR	CC, 22Ω, 1/4W, 5%	01121	5-10220
R18	RCR07G473JR	CC, 47KΩ, 1/4W, 5%	01121	5-10473
R19	RCR07G223JR	CC, 22KΩ, 1/4W, 5%	01121	5-10223
R20	RCR07G333JR	CC, 33KΩ, 1/4W, 5%	01121	5-10333
R21	RCR07G100JR	CC, 10Ω, 1/4W, 5%	01121	5-10100
R22	RCR07G332JR	CC, 3.3KΩ, 1/4W, 5%	01121	5-10332
R23	RCR07G100JR	CC, 10Ω, 1/4W, 5%	01121	5-10100
R24	RCR07G273JR	CC, 27KΩ, 1/4W, 5%	01121	5-10273
R25	RCR07G153JR	CC, 15KΩ, 1/4W, 5%	01121	5-10153
R26	RCR07G272JR	CC, 2.7KΩ, 1/4W, 5%	01121	5-10272
R27	RCR07G101JR	CC, 100Ω,1/4W, 5%	01121	5-10101
R28	RCR07G124JR	CC, 120KΩ, 1/4W, 5%	01121	5-10124
R29	RCR07G101JR	CC, 100Ω, 1/4W, 5%	01121	5-10101
R30	RCR07G331JR	CC, 330Ω, 1/4W, 5%	01121	5-10331
R31	RCR07G103JR	CC, 10KΩ, 1/4W, 5%	01121	5-10103
R32	RCR07G103JR	CC, 10KΩ, 1/4W, 5%	01121	5-10103
R33	RN55D3921F	MF, 3.92KΩ, 1/8W, 1%	91637	5-51250
R34	360T501B	Var, Cer, 500Ω	71450	5-73501
R35	RN55D2431F	MF, 2.43KΩ, 1/8W, 1%	91637	5-51230
R36	RCR07G681JR	CC, 680Ω, 1/4W, 5%	01121	5-10681
R37	RCR07G182JR	CC, 1.8KΩ, 1/4W, 5%	01121	5-10182
R38	RCR07G471JR	CC, 470Ω, 1/4W, 5%	01121	5-10471
R39	RCR07G272JR	CC, 2.7KΩ, 1/4W, 5%	01121	5-10272
R40	RCR07G681JR	CC, 680Ω, 1/4W, 5%	01121	5-10681
R41	RCR07G100JR	CC, 10Ω, 1/4W, 5%	01121	5-10100
R42	RCR07G102JR	CC, 1KΩ, 1/4W, 5%	01121	5-10102
R43	RCR07G101JR	CC, 100Ω, 1/4W, 5%	01121	5-10101
R44	RCR07G822JR	CC, 8.2KΩ, 1/4W, 5%	01121	5-10822
R45	RN55D9091F	MF, 9.09KΩ, 1/8W, 1%	91637	5-51295
R46	RN55D8251F	MF, 8.25KΩ, 1/8W, 1%	91637	5-51291
R47	RCR07G153JR	CC, 15KΩ, 1/4W, 5%	01121	5-10153
R48	RCR07G332JR	CC, 3.3KΩ, 1/4W, 5%	01121	5-10332
R49	RCR07G333JR	CC, 33KΩ, 1/4W, 5%	01121	5-10333
R50	RCR07G102JR	CC, 1KΩ, 1/4W, 5%	01121	5-10102
R51	RCR07G332JR	CC, 3.3KΩ, 1/4W, 5%	01121	5-10332
R52	RCR07G106JR	CC, 10MΩ, 1/4W, 5%	01121	5-10106
R53	RCR07G106JR	CC, 10MΩ, 1/4W, 5%	01121	5-10106

Table 6-9. Parts List (Master Board Sub-Assembly 9155001) (Continued)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
R54	RCR07G473JR	CC, 47KΩ, 1/4W, 5%	01121	5-10473
R55	RCR07G473JR	CC, 47KΩ, 1/4W, 5%	01121	5-10473
R56	RCR07G333JR	CC, 33KΩ, 1/4W, 5%	01121	5-10333
R57	RCR07G332JR	CC, 3.3KΩ, 1/4W, 5%	01121	5-10332
R58	RCR07G472JR	CC, 4.7KΩ, 1/4W, 5%	01121	5-10472
R59	RCR07G391JR	CC, 390Ω, 1/4W, 5%	01121	5-10391
R60	RCR07G822JR	CC, 8.2KΩ, 1/4W, 5%	01121	5-10822
R61	RCR07G392JR	CC, 3.9KΩ, 1/4W, 5%	01121	5-10392
R62	RCR07G512JR	CC, 5.1KΩ, 1/4W, 5%	01121	5-10512
R63	RN55D1822F	MF, 18.2KΩ, 1/8W, 1%	91637	5-51324
R64	RN55D4751F	MF, 4.75KΩ, 1/8W, 1%	91637	5-51268
R65	RN55D5110F	MF, 511Ω, 1/8W, 1%	91637	5-51164
R66	RCR07G102JR	CC, 1KΩ, 1/4W, 5%	01121	5-10102
R67	RCR07G332JR	CC, 3.3KΩ, 1/4W, 5%	01121	5-10332
R68	RN55D6192F	MF, 61.9KΩ, 1/8W, 1%	91637	5-51374
R69	RCR07G221JR	CC, 220Ω, 1/4W, 5%	01121	5-10221
R70	RCR07G221JR	CC, 220Ω, 1/4W, 5%	01121	5-10221
R71	RCR07G102JR	CC, 1KΩ, 1/4W, 5%	01121	5-10102
R72	RCR07G332JR	CC, 3.3KΩ, 1/4W, 5%	01121	5-10332
R73	RN55D6192F	MF, 61.9KΩ, 1/8W, 1%	91637	5-51374
R74	RN55D4751F	MF, 4.75KΩ, 1/8W, 1%	91637	5-51268
R75	RN55D5110F	MF, 511Ω, 1/8W, 1%	91637	5-51164
R76	RN55D1822F	MF, 18.2KΩ, 1/8W, 1%	91637	5-51324
R77	RCR07G100JR	CC, 10Ω, 1/4W, 5%	01121	5-10100
R78	RCR07G273JR	CC, 27KΩ, 1/4W, 5%	01121	5-10273
R79	RN55D5110F	MF, 511Ω, 1/8W, 1%	91637	5-51164
R80	RN55D4751F	MF, 4.75KΩ, 1/8W, 1%	91637	5-51268
R81	RCR07G332JR	CC, 3.3KΩ, 1/4W, 5%	01121	5-10332
R82	RCR07G102JR	CC, 1KΩ, 1/4W, 5%	01121	5-10102
R83	RCR07G221JR	CC, 220Ω, 1/4W, 5%	01121	5-10221
R84	RCR07G221JR	CC, 220Ω, 1/4W, 5%	01121	5-10221
R85	RCR07G332JR	CC, 3.3KΩ, 1/4W, 5%	01121	5-10332
R86	RCR07G102JR	CC, 1KΩ, 1/4W, 5%	01121	5-10102
R87	RN55D5110F	MF, 511Ω, 1/8W, 1%	91637	5-51164
R88	RN55D4751F	MF, 4.75KΩ, 1/8W, 1%	91637	5-51268
R89	RCR07G183JR	CC, 18KΩ, 1/4W, 5%	01121	5-10183
R90	RCR07G101JR	CC, 100Ω, 1/4W, 5%	01121	5-10101
R91	RCR07G123JR	CC, 12KΩ, 1/4W, 5%	01121	5-10123
R92	RCR07G103JR	CC, 10KΩ, 1/4W, 5%	01121	5-10103
R93	360T202B	Var, Cer, 2KΩ	71450	5-73202
R94	RCR07G271JR	CC, 270Ω, 1/4W, 5%	01121	5-10271
R95	360T253B	Var, Cer, 25KΩ	71450	5-73253
R96	RCR07G102JR	CC, 1KΩ, 1/4W, 5%	01121	5-10102

Table 6-9. Parts List (Master Board Sub-Assembly 9155001) (Continued)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
R97	RCR07G682JR	CC, 6.8KΩ, 1/4W, 5%	01121	5-10682
R98	RCR07G682JR	CC, 6.8KΩ, 1/4W, 5%	01121	5-10682
R99	RN55D1401F	MF, 1.40KΩ, 1/8W, 1%	91637	5-51207
R100	360T501B	Var, Cer, 500Ω	71450	5-73501
R101	RN55D7321F	MF, 7.32KΩ, 1/8W, 1%	91637	5-51286
R102	RN55D1912F	MF, 19.1KΩ, 1/8W, 1%	91637	5-51326
R103	RCR07G102JR	CC, 1KΩ, 1/4W, 5%	01121	5-10102
R104	RCR07G100JR	CC, 10Ω, 1/4W, 5%	01121	5-10100
R105	RCR07G102JR	CC, 1KΩ, 1/4W, 5%	01121	5-10102
R106	RCR07G910JR	CC, 91Ω, 1/4W, 5%	01121	5-10910
R107	RCR07G105JR	CC, 1MΩ, 1/4W, 5%	01121	5-10105
R108	RCR07G332JR	CC, 3.3KΩ, 1/4W, 5%	01121	5-10332
R109				
R110	RCR07G100JR	CC, 10Ω, 1/4W, 5%	01121	5-10100
R111	RCR07G510JR	CC, 51Ω, 1/4W, 5%	01121	5-10510
R112	RCR07G473JR	CC, 47KΩ, 1/4W, 5%	01121	5-10473
R113	RCR07G473JR	CC, 47KΩ, 1/4W, 5%	01121	5-10473
R114	RCR07G271JR	CC, 270Ω, 1/4W, 5%	01121	5-10271
R115	RCR07G271JR	CC, 270Ω, 1/4W, 5%	01121	5-10271
R116	RCR07G273JR	CC, 27KΩ, 1/4W, 5%	01121	5-10273
R117	360T103B	Var, Cer, 10KΩ	71450	5-73103
R118	RCR07G273JR	CC, 27KΩ, 1/4W, 5%	01121	5-10273
R119	RN55D1502F	MF, 15.0KΩ, 1/8W, 1%	91637	5-51316
R120	RN55D1502F	MF, 15.0KΩ, 1/8W, 1%	91637	5-51316
R121	RCR07G100JR	CC, 10Ω, 1/4W, 5%	01121	5-10100
R122	RN55D3012F	MF, 30.1KΩ, 1/8W, 1%	91637	5-51345
R123	RN55D3012F	MF, 30.1KΩ, 1/8W, 1%	91637	5-51345
R124	RCR07G100JR	CC, 10Ω, 1/4W, 5%	01121	5-10100
R125	RN55D1001F	MF, 1.00KΩ, 1/8W, 1%	91637	5-51193
R126	360T501B	Var, Cer, 500Ω	71450	5-73501
R127	RCR07G680JR	CC, 68Ω, 1/4W, 5%	01121	5-10680
R128	RCR07G680JR	CC, 68Ω, 1/4W, 5%	01121	5-10680
R129	RCR07G682JR	CC, 6.8KΩ, 1/4W, 5%	01121	5-10682
R130	360T102B	Var, Cer, 1KΩ	71450	5-73102
R131	RCR07G682JR	CC, 6.8KΩ, 1/4W, 5%	01121	5-10682
R132	RCR07G151JR	CC, 150Ω, 1/4W, 5%	01121	5-10151
R133	RCR07G823JR	CC, 82KΩ, 1/4W, 5%	01121	5-10823
R134	RCR08G822JR	CC, 8.2KΩ, 1/4W, 5%	01121	5-10822
R135	RCR07G151JR	CC, 150Ω, 1/4W, 5%	01121	5-10151
R136	RCR07G823JR	CC, 82KΩ, 1/4W, 5%	01121	5-10823
R137	RCR07G822JR	CC, 8.2KΩ, 1/4W, 5%	01121	5-10822
R138	RCR07G823JR	CC, 82KΩ, 1/4W, 5%	01121	5-10823
R139	RCR07G151JR	CC, 150Ω, 1/4W, 5%	01121	5-10151

Table 6-9. Parts List (Master Board Sub-Assembly 9155001) (Continued)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
R140	RCR07G822JR	CC, 8.2KΩ, 1/4W, 5%	01121	5-10822
R141	RCR07G151JR	CC, 150Ω, 1/4W, 5%	01121	5-10151
R142	RCR07G823JR	CC, 82KΩ, 1/4W, 5%	01121	5-10823
R143	RCR07G151JR	CC, 150Ω, 1/4W, 5%	01121	5-10151
R144	RCR07G822JR	CC, 8.2KΩ, 1/4W, 5%	01121	5-10822
R145	RCR07G151JR	CC, 150Ω, 1/4W, 5%	01121	5-10151
R146	RCR07G101JR	CC, 100Ω, 1/4W, 5%	01121	5-10101
R147	RCR07G101JR	CC, 100Ω, 1/4W, 5%	01121	5-10101
R148	RCR07G101JR	CC, 100Ω, 1/4W, 5%	01121	5-10101
R149	RCR07G101JR	CC, 100Ω, 1/4W, 5%	01121	5-10101
R150	RCR076XXXJR	CC, TBD, 1/4W, 5%	01121	5-10XXX
R151	RCR07GXXXJR	CC, TBD, 1/4W, 5%	01121	5-10XXX
R152	RCR07GXXXJR	CC, TBD, 1/4W, 5%	01121	5-10XXX
R153	360T202B	Var, Cer, 2KΩ	71450	5-73202
R154	RCR07G511JR	CC, 510Ω, 1/4W, 5%	01121	5-10511
R155	RCR07G102JR	CC, 1KΩ, 1/4W, 5%	01121	5-10102
R156	RCR07G182JR	CC, 1.8KΩ, 1/4W, 5%	01121	5-10182
R157	RCR07G911JR	CC, 910Ω, 1/4W, 5%	01121	5-10911
R158	360T501B	Var, Cer, 500Ω	71450	5-73501
R159	RCR07G511JR	CC, 510Ω, 1/4W, 5%	01121	5-10511
R160	RCR07G390JR	CC, 39Ω, 1/4W, 5%	01121	5-10390
R161	RCR07G181JR	CC, 180Ω, 1/4W, 5%	01121	5-10181
R162	RCR07G102JR	CC, 1KΩ, 1/4W, 5%	01121	5-10102
R163	RN55D6811F	MF, 6.81KΩ, 1/8W, 1%	91637	5-51283
R164	RN55D3920F	MF, 392Ω, 1/8W, 1%	91637	5-51153
R165	RN55D2100F	MF, 210Ω, 1/8W, 1%	91637	5-51127
R166	RN55D4021F	MF, 4.02KΩ, 1/8W, 1%	91637	5-51261
R167	RN55D4021F	MF, 4.02KΩ, 1/8W, 1%	91637	5-51261
R168	RN55D3920F	MF, 392Ω, 1/8W, 1%	91637	5-51153
R169	RN55D2100F	MF, 210Ω, 1/8W, 1%	91637	5-51127
R170	RCR07G181JR	CC, 180Ω, 1/4W, 5%	01121	5-10181
R171	RCR07G102JR	CC, 1KΩ, 1/4W, 5%	01121	5-10102
R172	RN55D6811F	MF, 6.81KΩ, 1/8W, 1%	91637	5-51283
R173	RCR07G390JR	CC, 39Ω, 1/4W, 5%	01121	5-10390
R174	RCR07G100JR	CC, 10Ω, 1/4W, 5%	01121	5-10100
R175	RCR07G102JR	CC, 1KΩ, 1/4W, 5%	01121	5-10102
R176	RCR07G390JR	CC, 39Ω, 1/4W, 5%	01121	5-10390
R177	RCR07G181JR	CC, 180Ω, 1/4W, 5%	01121	5-10181
R178	RN55D2100F	MF, 210Ω, 1/8W, 1%	91637	5-51127
R179	RN55D3920F	MF, 392Ω, 1/8W, 1%	91637	5-51153
R180	RCR07G153JR	CC, 15KΩ, 1/4W, 5%	01121	5-10153
R181	RN55D2100F	MF, 210Ω, 1/8W, 1%	91637	5-51127
R182	RN55D3920F	MF, 392Ω, 1/8W, 1%	91637	5-51153

Table 6-9. Parts List (Master Board Sub-Assembly 9155001) (Continued)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
R183	RCR07G102JR	CC, 1KΩ, 1/4W, 5%	01121	5-10102
R184	RCR07G181JR	CC, 180Ω, 1/4W, 5%	01121	5-10181
R185	RCR07G390JR	CC, 39Ω, 1/4W, 5%	01121	5-10390
R186	RCR07G100JR	CC, 10Ω, 1/4W, 5%	01121	5-10100
R187	RCR07G511JR	CC, 510Ω, 1/4W, 5%	01121	5-10511
R188	RN55D3741F	MF, 3.74KΩ, 1/8W, 1%	91637	5-51248
R189	RN55D4221F	MF, 4.22KΩ, 1/8W, 1%	91637	5-51263
R190	RN55D1001F	MF, 1.00KΩ, 1/8W, 1%	91637	5-51193
R191	RN55D3010F	MF, 301Ω, 1/8W, 1%	91637	5-51142
R192	RN55D1000F	MF, 100Ω, 1/8W, 1%	91637	5-51096
R193	RN55D1210F	MF, 121Ω, 1/8W, 1%	91637	5-51104
R194	360T201B	Var, Cer, 200Ω	71450	5-73201
R195	RN55D1000F	MF, 100Ω, 1/8W, 1%	91637	5-51096
R196	RN55D3741F	MF, 3.74KΩ, 1/8W, 1%	91637	5-51248
R197	RN55D1001F	MF, 1.00KΩ, 1/8W, 1%	91637	5-51193
R198	RN55D4221F	MF, 4.22KΩ, 1/8W, 1%	91637	5-51263
R199	RCR07G511JR	CC, 510Ω, 1/4W, 5%	01121	5-10511
R200	RN55D4991F	MF, 4.99KΩ, 1/8W, 1%	91637	5-51270
R201	RN55D1001F	MF, 1.00KΩ, 1/8W, 1%	91637	5-51193
R202	RN55D1001F	MF, 1.00KΩ, 1/8W, 1%	91637	5-51193
R203	RCR07G100JR	CC, 10Ω, 1/4W, 5%	01121	5-10100
R204	RN55D4991F	MF, 4.99KΩ, 1/8W, 1%	91637	5-51270
R205	RCR07G100JR	CC, 10Ω, 1/4W, 5%	01121	5-10100
R206	Type BWH	WW, .33Ω, 2W, 5%	TRW	5-30033
R207	RCR07G221JR	CC, 220Ω, 1/4W, 5%	01121	5-10221
R208	RCR07G222JR	CC, 2.2KΩ, 1/4W, 5%	01121	5-10222
R209	RCR07G123JR	CC, 12KΩ, 1/4W, 5%	01121	5-10123
R210	RCR07G101JR	CC, 100Ω, 1/4W, 5%	01121	5-10101
R211	RCR07G102JR	CC, 1KΩ, 1/4W, 5%	01121	5-10102
R212	RN55D5112F	MF, 51.1KΩ, 1/8W, 1%	91637	5-51367
R213	360T103B	Var, Cer, 10KΩ	71450	5-73103
R214	RN55D3922F	MF, 39.2KΩ, 1/8W, 1%	91637	5-51356
R215	RCR42G111JR	CC, 110Ω, 2W, 5%	01121	5-40111
R216	RCR07G300JR	CC, 30Ω, 1/4W, 5%	01121	5-10300
R217	RCR07G300JR	CC, 30Ω, 1/4W, 5%	01121	5-10300
R218	RCR07G150JR	CC, 15Ω, 1/4W, 5%	01121	5-10150
R219	RCR20G1R0JR	CC, 1Ω, 1/2W, 5%	01121	5-20010
R220		TBD		
R221	RCR07G392JR	CC, 3.9KΩ, 1/4W, 5%	01121	5-10392
R222				
R223	RN55D8251F	MF, 8.25KΩ, 1/8W, 1%	91637	5-51291
R224	360T202B	Var, Cer, 2KΩ	71450	5-73202
R225	RN55D2741F	MF, 2.74KΩ, 1/8W, 1%	91637	5-51235

Table 6-9. Parts List (Master Board Sub-Assembly 9155001) (Continued)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
R226	RN55D5811F	MF, 6.81KΩ, 1/8W, 1%	91637	5-51283
R227	360T102B	Var, Cer, 1KΩ	71450	5-73102
R228	RN55D4750F	MF, 475Ω, 1/8W, 1%	91637	5-51161
R229	RCR07G103JR	CC, 10KΩ, 1/4W, 5%	01121	5-10103
R230	RCR07G822JR	CC, 8.2KΩ, 1/4W, 5%	01121	5-10822
R231	RCR07G823JR	CC, 82KΩ, 1/4W, 5%	01121	5-10823
R232	RCR07G823JR	CC, 82KΩ, 1/4W, 5%	01121	5-10823
R233	RCR07G823JR	CC, 82KΩ, 1/4W, 5%	01121	5-10823
R234	RCR07G822JR	CC, 8.2KΩ, 1/4W, 5%	01121	5-10822
R235	RCR07G823JR	CC, 82KΩ, 1/4W, 5%	01121	5-10823
R236	RCR07G103JR	CC, 10KΩ, 1/4W, 5%	01121	5-10103
R237	360T104B	Var, Cer, 100KΩ	71450	5-73104
R238	RCR07G103JR	CC, 10KΩ, 1/4W, 5%	01121	5-10103
R239	RCR07G101JR	CC, 100Ω, 1/4W, 5%	01121	5-10101
R240	RCR07G331JR	CC, 330Ω, 1/4W, 5%	01121	5-10331
R241	RCR07G222JR	CC, 2.2KΩ, 1/4W, 5%	01121	5-10222
R242	RCR07G273JR	CC, 27KΩ, 1/4W, 5%	01121	5-10273
R243	RCR07G101JR	CC, 100Ω, 1/4W, 5%	01121	5-10101
R244	RCR07G273JR	CC, 27KΩ, 1/4W, 5%	01121	5-10273
R245	RCR07G272JR	CC, 2.7KΩ, 1/4W, 5%	01121	5-10272
R246	RCR07G822JR	CC, 8.2KΩ, 1/4W, 5%	01121	5-10822
R247	RCR07G273JR	CC, 27KΩ, 1/4W, 5%	01121	5-10273
R248-N	RCR07G474JR	CC, 470KΩ, 1/4W, 5%	01121	5-10474
R249	RCR07G272JR	CC, 2.7KΩ, 1/4W, 5%	01121	5-10272
R250	360T254B	Var, Cer, 250KΩ	71450	5-73254
R251	RCR20G105JR	CC, 1MΩ, 1/2W, 5%	01121	5-20105
R252-N	RCR20G106JR	CC, 10MΩ, 1/2W, 5%	01121	5-20106
R253	RCR20G105JR	CC, 1MΩ, 1/2W, 5%	01121	5-20105
R254	RCR07G152JR	CC, 1.5KΩ, 1/4W, 5%	01121	5-10152
R255	RCR07G221JR	CC, 220Ω, 1/4W, 5%	01121	5-10221
R256	RCR07G472JR	CC, 4.7KΩ, 1/4W, 5%	01121	5-10472
R257	RCR07G104JR	CC, 100KΩ, 1/4W, 5%	01121	5-10104
R258	RCR07G104JR	CC, 100KΩ, 1/4W, 5%	01121	5-10104
R259	RCR07G334JR	CC, 330KΩ, 1/4W, 5%	01121	5-10334
R260	RCR07G103JR	CC, 10KΩ, 1/4W, 5%	01121	5-10103
R261	RCR07G472JR	CC, 4.7KΩ, 1/4W, 5%	01121	5-10472
R262	RCR07G104JR	CC, 100KΩ, 1/4W, 5%	01121	5-10104
R263	RCR07G104JR	CC, 100KΩ, 1/4W, 5%	01121	5-10104
R264	RCR07G104JR	CC, 100KΩ, 1/4W, 5%	01121	5-10104
R265	RCR07G221JR	CC, 220Ω, 1/4W, 5%	01121	5-10221
R266	RCR07G332JR	CC, 3.3KΩ, 1/4W, 5%	01121	5-10332
R267	RCR07G101JR	CC, 100Ω, 1/4W, 5%	01121	5-10101
R268	RCR07G101JR	CC, 100Ω, 1/4W, 5%	01121	5-10101

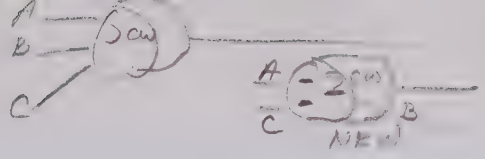


Table 6-9. Parts List (Master Board Sub-Assembly 9155001) (Continued)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
R269	RCR07G103JR	CC, 10KΩ, 1/4W, 5%	01121	5-10103
R270	RCR07G472JR	CC, 4.7KΩ, 1/4W, 5%	01121	5-10472
R271	MLCN56L	Var, Carbon, 5MΩ	90201	~~5-78505~~
R272	MLCN54L	Var, Carbon, 50KΩ	90201	5-78503
R273	RCR07G471JR	CC, 470Ω, 1/4W, 5%	01121	5-10471
R274	RCR07G103JR	CC, 10KΩ, 1/4W, 5%	01121	5-10103
R275	RCR07G106JR	CC, 10MΩ, 1/4W, 5%	01121	5-10106
R276	RCR07G270JR	CC, 27Ω, 1/4W, 5%	01121	5-10270
R277-N	RCR07G683JR	CC, 68KΩ, 1/4W, 5%	01121	5-10683
R278	RCR07GXXXJR	CC, TBD, 1/4W, 5%	01121	5-10XXX
S1	9152002	Trigger Switch	34160	2-10046
S2	9152003	Input Coupling Switch	34160	2-10047
XV1	B14G	Socket, Crt	Inter-Technical Group, Inc.	2-60005
		TERMINALS		
TP1	2970-01-03	Terminal	Cambion	2-23998
TP2	2970-01-03	Terminal	Cambion	2-23998
TP3	2970-01-03	Terminal	Cambion	2-23998
TP4	2970-01-03	Terminal	Cambion	2-23998
TP5	2970-01-03	Terminal	Cambion	2-23998
2 Req.	MP170-2	Mini-Pin, .6 Long	PMP	2-24015
		TRANSISTORS		
Q1*	F2701	Fet, N Ch	Solitron	3-22701
Q2*	F2701	Fet, N Ch	Solitron	3-22701
Q3	2N3694	NPN, Signal	07263	3-23694
Q4	2N3694	NPN, Signal	07263	3-23694
Q5	2N4250	PNP, Signal	07263	3-24250
Q6	2N4250	PNP, Signal	07263	3-24250
Q7	2N4275	NPN, Signal	07263	3-24275
Q8	2N4870	PN, Unijunction	04713	3-24870
Q9	2N4275	NPN, Signal	07263	3-24275
Q10	2N4275	NPN, Signal	07263	3-24275
Q11	2N4275	NPN, Signal	07263	3-24275
Q12	2N3906	PNP, Signal	04713	3-23906
Q13	2N3906	PNP, Signal	04713	3-23906
Q14	2N3904	NPN, Signal	04713	3-23904
Q15	2N3904	NPN, Signal	04713	3-23904
Q16	F2701	Fet, N Ch	Solitron	3-22701

*Matched Set, low pinch-off.

Table 6-9. Parts List (Master Board Sub-Assembly 9155001) (Continued)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
Q17	F2701	Fet, N Ch	Solitron	3-22701
Q18	2N3904	NPN, Signal	04713	3-23904
Q19	2N3906	PNP, Signal	04713	3-23906
Q20	2N4275	NPN, Signal	07263	3-24275
Q21	2N3906	PNP, Signal	04713	3-23906
Q22	MPSH04	NPN, Signal	04713	3-20004
Q23	MPSH54	PNP, Signal	04713	3-20054
Q24	2N5401	PNP, Signal	04713	3-25401
Q25	2N5401	PNP, Signal	04713	3-25401
Q26	MPSH54	PNP, Signal	04713	3-20054
Q27	MPSH04	NPN, Signal	04713	3-20004
Q28	MPSH54	PNP, Signal	04713	3-20054
Q29	MPSH04	NPN, Signal	04713	3-20004
Q30	2N5550	NPN, Signal	04713	3-25550
Q31	2N5550	NPN, Signal	04713	3-25550
Q32	MPSH04	NPN, Signal	04713	3-20004
Q33	MPSH54	PNP, Signal	04713	3-20054
Q34	2N3904	NPN, Signal	04713	3-23904
Q35	2N3904	NPN, Signal	04713	3-23904
Q36	2N3904	NPN, Signal	04713	3-23904
Q37	MPSH04	NPN, Signal	04713	3-20004
Q38	F2762	Fet, N Ch	Solitron	3-22762
Q39	2N3646	NPN, Signal	07263	3-23646
Q40	2N3904	NPN, Signal	04713	3-23904
Q41	2N3904	NPN, Signal	04713	3-23904
Q42				
Q43				
Q44				
Q45				
Q46	2N3906	PNP, Signal	04713	3-23906
Q47	2N3906	PNP, Signal	04713	3-23906
Q48	2N3906	PNP, Signal	04713	3-23906
Q49	2N3906	PNP, Signal	04713	3-23906
Q50	2N3906	PNP, Signal	04713	3-23906
Q51	2N3906	PNP, Signal	04713	3-23906
Q52	2N3906	PNP, Signal	04713	3-23906
Q53	2N3906	PNP, Signal	04713	3-23906
Q54	2N3904	NPN, Signal	04713	3-23904
Q55	2N3904	NPN, Signal	04713	3-23904
Q56	2N3906	PNP, Signal	04713	3-23906
Q57	2N3906	PNP, Signal	04713	3-23906
Q58	2N3904	NPN, Signal	04713	3-23904
Q59	2N3904	NPN, Signal	04713	3-23904

Table 6-9. Parts List (Master Board Sub-Assembly 9155001) (Continued)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
Q60	2N3906	PNP, Signal	04713	3-23906
Q61	2N3906	PNP, Signal	04713	3-23906
Q62	2N3904	NPN, Signal	04713	3-23904
Q63	2N3904	NPN, Signal	04713	3-23904
Q64	2N3904	NPN, Signal	04713	3-23904
Q65	2N3904	NPN, Signal	04713	3-23904
Q66	2N3906	PNP, Signal	04713	3-23906
Q67	2N3906	PNP, Signal	04713	3-23906
Q68	2N3904	NPN, Signal	04713	3-23904
Q69	2N3904	NPN, Signal	04713	3-23904
Q70	2N3904	NPN, Signal	04713	3-23904
Q71	2N3694	NPN, Signal	07263	3-23694
Q72	2N3694	NPN, Signal	07263	3-23694
Q73	D44C3	NPN, Power	GE	3-244C3
Q74	D44C3	NPN, Power	GE	3-244C3
Q75	D44H2	NPN, Power	GE	3-24442
Q76				
Q77				
Q78	2N4275	NPN, Signal	07263	3-24275
Q79	2N4275	NPN, Signal	07263	3-24275
Q80	2N4275	NPN, Signal	07263	3-24275
Q81	2N4870	PN, Unijunction	04713	3-24870
Q82	2N5401	PNP, Signal	04713	3-25401
Q83	2N4250	PNP, Signal	07263	3-24250
Q84	2N3906	PNP, Signal	04713	3-23906
Q85	2N3906	PNP, Signal	04713	3-23906
Q86	2N3904	NPN, Signal	04713	3-23904
Q87	2N3904	NPN, Signal	04713	3-23904
Q88	2N3904	NPN, Signal	04713	3-23904
Q89	2N3906	PNP, Signal	04713	3-23906
Q90	2N3906	PNP, Signal	04713	3-23906
Q91	MPSA43	NPN, Power, HV	04713	3-20043
Q92	2N3906	PNP, Signal	04713	3-23906
		TRANSFORMERS		
T1	9152006-1	DC-DC Inverter-Driver	34160	7-61020
T2	9152006-3	DC-DC Inverter-Intermediate	34160	7-61021
T3	9152006-5	DC-DC Inverter-Hi Voltage	34160	7-61022
		MISCELLANEOUS		
6 Req.	9152030	Button	34160	1-10716
9 Req.	200C	Bifurcated Terminal	USECO	
	9152021	Bracket-HV Pots	34160	1-10708
2 Req.	S0-440-8	4-40 Captive Standoff, ¼"L	46384	

Table 6-9. Parts List (Master Board Sub-Assembly 9155001) (Continued)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
2 Req.	KF2-440	4-40 Spline Nut	46384	
	1465	Terminal Lug, Locking	83330	
	MS51957-13	Screw, Panhead, 4-40 X ¼"		
5 Req.	MS35333-70	Washer, #4 Int. Lk.		
2 Req.	MS35333-71	Washer, #6 Int. Lk.		
2 Req.	NAS671C6	Nut, #6 Plain Hex		
4 Req.	570-1510-01-0519	Standoff	Cambion	4-20199
4 Req.	MS51957-12	Screw, Panhead, 4-40X 3/16"		
4 Req.	2664	Washer, Shoulder, Nylon	83330	

Table 6-10. Parts List (Battery Pack Option Assembly 9155016)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
2 Req.	GC645-1B	Battery, Globe 6 Volt, 4-5 Amp-HP	Globe	4-20249
	9152032	Battery Support	34160	1-10731
	9152031	Battery Strap—Rear	34160	1-10732
2 Req.	9152039	Foot Arch	34160	1-10733
	9152033	Battery Cover	34160	1-10734
2 Req.	9152037	T.F. Foot	34160	1-10724
	9152041	Battery Strap—Front	34160	1-10735
	2244 Black	Miniature Banana Plug—Blk	Pomona	2-24012
2 Req.	B-312-250	Heyco Miniature Bushing	Heyco	
6 Req.	F4	Cabinet Foot—Black	Budwig	4-20037
12"		1/4" thick X 3/8" wide Foam Tape w/Adh.		
4 Req.	MS51957-26	Screw 6-32 X 1/4" Panhead		
4 Req.	MS35333-71	Washer, #6 Int. Lock		
4 Req.	MS24693-2	Screw 4-40 X 1/4" 100° Flat		
6 Req.	MS51957-13	Screw 4-40 X 1/4" Pan		
2 Req.	MS51957-15	Screw 4-40 X 3/8" Pan		
4 Req.	MS51957-17	Screw 4-40 X 1/2" Pan		
4 Req.	NAS671C4	Nut #4		
12 Req.	MS35333-70	Washer #4 Internal Lock		
	9402103	Battery Caution Decal	34160	4-20255
2 Req.	4056 (H.H.Smith)	Nylon Spacer, 1/4 O.D. X 1/2 LN, 4-40 Tars	83330	4-20250
2 Req.		Nylon Screw, 4-40 X 3/16 100° Flat	Gries	
AR	18 Ga. AWG	Wire — Black & Red		

Table 6-11. Parts List (Chassis Assembly 9755006)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
	9755001	Dmm-Freq Counter Sub-Assy.	34160	
	9752003	Front Panel	34160	1-10723
	9752004	Sub Panel	34160	1-10720
2 Req.	9752005	Mounting Plate	34160	1-10725
J302	2142-5	Banana Jack — Green	Pomona	4-20251
J301	2142-2	Banana Jack — Red	Pomona	4-20158
	A2197	Eyelet, Rolled Flange	Stimpson	
	MS24693-2	Screw, 100° Flathead 4-40 X 1/4"		
3 Req.	MS51957-13	Screw, Panhead, 4-40 X 1/4"		
3 Req.	MS35333-70	Washer, Int. Lk. #4		
4 Req.	AD42ABS	Pop Rivet	USM	

Table 6-12. Parts List (Dmm/Freq Counter Sub-Assembly 9755001)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
	9753001	Etched Circuit Bd.	34160	1-20088
		CAPACITORS		
C1	C4003/1B	Var, Mica, 4–45pF	84171	6-96004
C2	DDM-103	CD, .01μF +60–40%, 150V	71490	6-27103
C3	T362D107M020AS	TANT, 100μF ±20%, 20V	05397	6-74107
C4	UK20-104	CD, .1μF +80 –20%, 20V	71590	6-24104
C5	UK20-104	CD, .1μF +80 –20%, 20V	71590	6-24104
C6	DM15-150J	DM, 15pF ±5%, 500V	04062	6-19150
C7	UK20-104	CD, .1μF +80 –20%, 20V	71590	6-24104
C8	UK20-104	CD, .1μF +80 –20%, 20V	71590	6-24104
C9	UK20-104	CD, .1μF +80 –20%, 20V	71590	6-24104
C10	DM15-471J	DM, 470pF ±5%, 500V	04062	6-19471
C11	UK25-223	CD, .022μF ±20%, 25V	71590	6-24203
C12	UK20-104	CD, .1μF +80 –20%, 20V	71590	6-24104
C13	D155F560J	DM, 56pF ±5%, 500V	00853	6-19560
C14	D155F560J	DM, 56pF ±5%, 500V	00853	6-19560
C15	DDM-103	CD, .01μF +60 –40%, 150V	71590	6-27103
C16	5GA-S10	CD, .01μF ±20%, 1KV	56289	6-29053
C17	T362C336M020AS	TANT, 33μF ±20%, 20V	05397	6-74336
C18	UK20-104	CD, .1μF +80 –20%, 20V	71590	6-24104
C19	T362C336M020AS	TANT, 33μF ±20%, 20V	05397	6-74336
C20	DDM-103	CD, .01μF +60 –40%, 150V	71590	6-27103
C21	DDM-103	CD, .01μF +60 –40%, 150V	71590	6-27103
C22	T362C336M020AS	TANT, 33μF ±20%, 20V	05397	6-74336
C23	DM15-100J	DM, 10pF ±5%, 500V	04062	6-19100
C24	DM15-150J	DM, 15pF ±5%, 500V	04062	6-19150
C25	DM15-330J	DM, 33pF ±5%, 500V	04062	6-19330
C26	DDM-103	CD, .01μF +60 –40%, 150V	71590	6-27103
C27	DDM-103	CD, .01μF +60 –40%, 150V	71590	6-27103
C28	T362C226M035AS	TANT, 22μF ±20%, 35V	05397	6-75226
C29	T362C476M020AS	TANT, 47μF ±20%, 20V	05397	6-74476
C30	D155F560J	DM, 56pF ±5%, 500V	00853	6-19560
C31	DDM-103	CD, .01μF +60 –40%, 150V	71590	6-27103
C32	DDM-103	CD, .01μF +60 –40%, 150V	71590	6-27103
C33	XA2A223J	MM, .022 ±5%, 50V	27556	6-46223
C34	XA2A153J	MM, .015 ±5%, 50V	27556	6-46153
C35	XA2A104J	MM, .1μF ±5%, 50V	27556	6-46104
C36	C4003/1B	Var, Mica, 4–45pF	84171	6-96004
C37	UK20-104	CD, .1μF +80 –20%, 20V	71590	6-24104
C38	UK20-104	CD, .1μF +80 –20%, 20V	71590	6-24104
C39	UK20-104	CD, .1μF +80 –20%, 20V	71590	6-24104
C40	T362B475M020AS	TANT, 4.7μF ±20%, 20V	05397	6-74475

Table 6-12. Parts List (Dmm/Freq Counter Sub-Assembly 9755001) (Continued)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
C41	DDM-103	CD, .01μF +60 −40%, 150V	71590	6-27103
C42	T362B475M020AS	TANT, 4.7μF ±20%, 20V	05397	6-74475
C43	UK20-104	CD, .1μF +80 −20%, 20V	71590	6-24104
C44	DDM-103	CD,.01μF +60 −40%, 150V	71590	6-27103
C45	T362D107M020AS	TANT, 100μF ±20%, 20V	05397	6-74107
C46	DDM-103	CD, .01μF +60 −40%, 150V	71590	6-27103
C47	T362D107M020AS	TANT, 100μF ±20%, 20V	05397	6-74107
C48	UK20-104	CD, .1μF +80 −20%, 20V	71590	6-24104
C49	T362D337M006AS	TANT, 330μF ±20%, 6V	05397	6-71337
C50	UK20-104	CD, .1μF +80 −20%, 20V	71590	6-24104
C51	UK20-104	CD, .1μF +80 −20%, 20V	71590	6-24104
C52	C4003/1B	Var, Mica, 4–45pF	84171	6-96004
C53	T362B226M010AS	TANT, 22μF ±20%, 10V	05397	6-72226
Y1	MD-18A	Crystal, 3.2768MHz	Monitor Labs	4-20241
		DIODES		
CR1	5082-2800	Schottky	H.P.	3-12800
CR2	1N914	GP, Signal	07263	3-10914
CR3	1N914	GP, Signal	07263	3-10914
CR4	1N914	GP, Signal	07263	3-10914
CR5	1N914	GP, Signal	07263	3-10914
CR6	1N914	GP, Signal	07263	3-10914
CR7	1N914	GP, Signal	07263	3-10914
CR8	1N914	GP, Signal	07263	3-10914
CR9	1N4576	Zener, 6.4V	04713	3-14576
CR10	1N914	GP, Signal	07263	3-10914
CR11	FD300	Low Leakage	07263	3-10300
CR12	FD300	Low Leakage	07263	3-10300
CR13	FD300	Low Leakage	07263	3-10300
CR14	FD300	Low Leakage	07263	3-10300
CR15	1N914	GP, Signal	07263	3-10914
CR16	1N914	GP, Signal	07263	3-10914
CR17	1N914	GP, Signal	07263	3-10914
CR18	1N914	GP, Signal	07263	3-10914
CR19	1N914	GP, Signal	07263	3-10914
CR20	1N914	GP, Signal	07263	3-10914
CR21	1N914	GP, Signal	07263	3-10914
CR22	1N914	GP, Signal	07263	3-10914
CR23	1N914	GP, Signal	07263	3-10914
CR24	1N914	GP, Signal	07263	3-10914
CR25	1N914	GP, Signal	07263	3-10914

Table 6-12. Parts List (Dmm/Freq Counter Sub-Assembly 9755001) (Continued)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
CR26	1N914	GP, Signal	07263	3-10914
CR27	FD300	Low Leakage	07263	3-10300
CR28	FD300	Low Leakage	07263	3-10300
CR29	1N914	GP, Signal	07263	3-10914
CR30	1N5239B	Zener, 9.1V	04713	3-15239
CR31	1N914	GP, Signal	07263	3-10914
CR32	1N914	GP, Signal	07263	3-10914
CR33	1N914	GP, Signal	07263	3-10914
CR34	1N914	GP, Signal	07263	3-10914
CR35	1N914	GP, Signal	07263	3-10914
CR36	1N914	GP, Signal	07263	3-10914
CR37	1N914	GP, Signal	07263	3-10914
		INTEGRATED CIRCUITS		
U1	SN74LS196N	Counter, Decade	01294	3-37196
U2	SN74LS196N	Counter, Decade	01294	3-37196
U3	SN74L90N	Counter, Decade	01294	3-34490
U4	SN74LS76N	Flip-Flop, Dual	01294	3-34476
U5	SN74LS02N	Gate, Nor	01294	3-37402
U6	SN74L10N	Gate, Nand	01294	3-37410
U7	SN74L90N	Counter, Decade	01294	3-34490
U8	SN74L90N	Counter, Decade	01294	3-34490
U9	LM318	OP, Amp	Nat'l	3-30318
U10	MK5007P	Counter, 4 Digit	Mostek	3-35007
U11	MC14511CP	Decoder Driver	04713	3-34511
U12	LM301	OP, Amp	Nat'l	3-30301
U13	SN74LS02N	Gate, Nor	01294	3-37402
U14	SN74L20N	Gate, Nand	01294	3-34420
U15	SN7416N	Hex Inverter Buffer, Driver	01294	3-37416
U16	LD111	A to D Converter	Siliconix	3-30111
U17	SN74L96N	Gate, Nand	01294	3-34496
U18	SN74LS02N	Gate, Nor	01294	3-37402
U19	NE555V	Timer	Signetics	3-30555
U20	MC14511CP	Decoder Driver	04713	3-34511
U21	LD110	A to D Converter	Siliconix	3-30110
U22	SN74L90N	Counter, Decade	01294	3-34490
U23	SN74LS76N	Flip-Flop, Dual	01294	3-34476
U24	MC14020CP	Counter, Binary	04713	3-34020
U25	LM301	OP, Amp	Nat'l	3-30301
U26	FD1753	Dual Fet	Solitron	3-21753
U27	LM301	OP, Amp	Nat'l	3-30301
U28	FD1753	Dual Fet	Solitron	3-21753
U29	LM318	OP, Amp	Nat'l	3-30318

Table 6-12. Parts List (Dmm/Freq Counter Sub-Assembly 9755001) (Continued)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
DS1	DL-34M	Led Display	Litronix	3-10234
DS2	T1L-209	Indicator Light	01294	3-10209
DS3	DL-34M	Led Display	Litronix	3-10234
		RESISTORS		
R1	RN55D3321F	MF, 3.32KΩ, 1/8W, 1%	91637	5-51243
R2	RN55D2211F	MF, 2.21KΩ, 1/8W, 1%	91637	5-51226
R3	RCR07G102JR	CC, 1KΩ, 1/4W, 5%	01121	5-10102
R4	RCR07G101JR	CC, 100Ω, 1/4W, 5%	01121	5-10101
R5-N	RN55D1101F	MF, 1.10KΩ, 1/8W, 1%	91637	5-51197
R6	RCR07G101JR	CC, 100Ω, 1/4W, 5%	01121	5-10101
R7	RCR07G102JR	CC, 1KΩ, 1/4W, 5%	01121	5-10102
R8	RCR07G103JR	CC, 10KΩ, 1/4W, 5%	01121	5-10103
R9	RCR07G162JR	CC, 1.6KΩ, 1/4W, 5%	01121	5-10162
R10	RCR07G471JR	CC, 470Ω, 1/4W, 5%	01121	5-10471
R11	RCR07G102JR	CC, 1KΩ, 1/4W, 5%	01121	5-10102
R12	RCR07G472JR	CC, 4.7KΩ, 1/4W, 5%	01121	5-10472
R13	RCR07G473JR	CC, 47KΩ, 1/4W, 5%	01121	5-10473
R14	RCR07G102JR	CC, 1KΩ, 1/4W, 5%	01121	5-10102
R15	RCR07G100JR	CC, 10Ω, 1/4W, 5%	01121	5-10100
R16	RCR07G100JR	CC, 10Ω, 1/4W, 5%	01121	5-10100
R17	RCR07G103JR	CC, 10KΩ, 1/4W, 5%	01121	5-10103
R18	RCR07G472JR	CC, 4.7KΩ, 1/4W, 5%	01121	5-10472
R19	RCR07G473JR	CC, 47KΩ, 1/4W, 5%	01121	5-10473
R20	RCR07G473JR	CC, 47KΩ, 1/4W, 5%	01121	5-10473
R21	RCR07G103JR	CC, 10KΩ, 1/4W, 5%	01121	5-10103
R22	RCR07G472JR	CC, 4.7KΩ, 1/4W, 5%	01121	5-10472
R23	RCR07G473JR	CC, 47KΩ, 1/4W, 5%	01121	5-10473
R24	RCR07G273JR	CC, 27KΩ. 1/4W, 5%	01121	5-10273
R25	RCR07G100JR	CC, 10Ω, 1/4W, 5%	01121	5-10100
R26	RCR07G472JR	CC, 4.7KΩ, 1/4W, 5%	01121	5-10472
R27	RCR07G472JR	CC, 4.7KΩ, 1/4W, 5%	01121	5-10472
R28	RCR07G472JR	CC, 4.7KΩ, 1/4W, 5%	01121	5-10472
R29	RCR07G472JR	CC, 4.7KΩ, 1/4W, 5%	01121	5-10472
R30	RCR07G473JR	CC, 47KΩ, 1/4W, 5%	01121	5-10473
R31	RCR07G473JR	CC, 47KΩ, 1/4W, 5%	01121	5-10473
R32	RCR07G473JR	CC, 47KΩ, 1/4W, 5%	01121	5-10473
R33	RCR07G473JR	CC, 47KΩ, 1/4W, 5%	01121	5-10473
R34	RCR07G223JR	CC, 22KΩ, 1/4W, 5%	01121	5-10223
R35	RCR07G223JR	CC, 22KΩ, 1/4W, 5%	01121	5-10223
R36	RCR07G223JR	CC, 22KΩ, 1/4W, 5%	01121	5-10223
R37	RCR07G223JR	CC, 22KΩ, 1/4W, 5%	01121	5-10223
R38	RCR07G103JR	CC, 10KΩ, 1/4W, 5%	01121	5-10103

Table 6-12. Parts List (Dmm/Freq Counter Sub-Assembly 9755001) (Continued)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
R39	RCR07G103JR	CC, 10KΩ, 1/4W, 5%	01121	5-10103
R40	RCR07G103JR	CC, 10KΩ, 1/4W, 5%	01121	5-10103
R41	RCR07G103JR	CC, 10KΩ, 1/4W, 5%	01121	5-10103
R42	RCR07G124JR	CC, 120KΩ, 1/4W, 5%	01121	5-10124
R43	RCR07G122JR	CC, 1.2KΩ, 1/4W, 5%	01121	5-10122
R44	RCR07G122JR	CC, 1.2KΩ, 1/4W, 5%	01121	5-10122
R45	RCR07G122JR	CC, 1.2KΩ, 1/4W, 5%	01121	5-10122
R46	RCR07G122JR	CC, 1.2KΩ, 1/4W, 5%	01121	5-10122
R47	RCR07G122JR	CC, 1.2KΩ, 1/4W, 5%	01121	5-10122
R48	RCR07G122JR	CC, 1.2KΩ, 1/4W, 5%	01121	5-10122
R49	RCR07G122JR	CC, 1.2KΩ, 1/4W, 5%	01121	5-10122
R50	RCR07G122JR	CC, 1.2KΩ, 1/4W, 5%	01121	5-10122
R51	RCR07G104JR	CC, 100KΩ, 1/4W, 5%	01121	5-10104
R52	RCR07G103JR	CC, 10KΩ, 1/4W, 5%	01121	5-10103
R53	RCR07G681JR	CC, 680Ω, 1/4W, 5%	01121	5-10681
R54	RN55D3010F	MF, 301Ω, 1/8W, 1%	91637	5-51142
R55	RCR07G754JR	CC, 750KΩ, 1/4W, 5%	01121	5-10754
R56	RN55D6341F	MF, 6.34KΩ, 1/8W, 1%	91637	5-51280
R57	360T201B	Var, Cer, 200Ω	71450	5-73201
R58	RN55D4990F	MF, 499Ω, 1/8W, 1%	91637	5-51163
R59	RN55D7681F	MF, 7.68KΩ, 1/8W, 1%	91637	5-51288
R60	360T102B	Var, Cer, 1KΩ	71450	5-73102
R61	RN55D4872F	MF, 48.7KΩ, 1/8W, 1%	91637	5-51365
R62	RCR07G683JR	CC, 68KΩ, 1/4W, 5%	01121	5-10683
R63	RCR07G683JR	CC, 68KΩ, 1/4W, 5%	01121	5-10683
R64	RN60D1004F	MF, 1MΩ, 1/4W, 1%	91637	5-50490
R65	RN55D1073F	MF, 107KΩ, 1/8W, 1%	91637	5-51397
R66	360T103B	Var, Cer, 10KΩ	71450	5-73103
R67	RCR07G224JR	CC, 220KΩ, 1/4W, 5%	01121	5-10224
R68	RN55D9761F	MF, 9.76KΩ, 1/8W, 1%	91637	5-51298
R69	360T102B	Var, Cer, 1KΩ	71450	5-73102
R70	RCR07G224JR	CC, 220KΩ, 1/4W, 5%	01121	5-10224
R71	RN55D9090F	MF, 909Ω, 1/8W, 1%	91637	5-51189
R72	360T101B	Var, Cer, 100Ω	71450	5-73101
R73	RCR07G224JR	CC, 220KΩ, 1/4W, 5%	01121	5-10224
R74	P57036	Thermistor	NL Ind.	5-81001
R75	RCR07G106JR	CC, 10MΩ, 1/4W, 5%	01121	5-10106
R76	PME70T2	MF, 10MΩ, 1W, 1%	Pyrofilm	5-59002
R77	RCR07G101JR	CC, 100Ω, 1/4W, 5%	01121	5-10101
R78	RN55D6812F	MF, 68.1KΩ, 1/8W, 1%	91637	5-51378
R79	RCR07G101JR	CC, 100Ω, 1/4W, 5%	01121	5-10101
R80	RN55D6812F	MF, 68.1KΩ, 1/8W, 1%	91637	5-51378
R81	RCR07G103JR	CC, 10KΩ, 1/4W, 5%	01121	5-10103

Table 6-12. Parts List (Dmm/Freq Counter Sub-Assembly 9755001) (Continued)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
R82	RCR07G225JR	CC, 2.2MΩ, 1/4W, 5%	01121	5-10225
R83	360T504B	Var, Cer, 500KΩ	71450	5-73504
R84	RCR7G100JR	CC, 10Ω, 1/4W, 5%	01121	5-10100
R85	RCR07G822JR	CC, 8.2KΩ, 1/4W, 5%	01121	5-10822
R86	RCR07G100JR	CC, 10Ω, 1/4W, 5%	01121	5-10100
R87	PME70T2	MF, 10MΩ, 1W, 1%	Pyrofilm	5-59002
R88	RN60D1004F	MF, 1MΩ, 1/4W, 1%	91637	5-50490
R89	360T254B	Var, Cer, 250KΩ	71450	5-73254
R90	RN55D9762F	MF, 97.6KΩ, 1/8W, 1%	91637	5-51393
R91	360T103B	Var, Cer, 10KΩ	71450	5-73103
R92	RN55D9531F	MF, 9.53KΩ, 1/8W, 1%	91637	5-51297
R93	360T102B	Var, Cer, 1KΩ	71450	5-73102
R94	RCR07G105JR	CC, 1MΩ, 1/4W, 5%	01121	5-10105
R95	360T504B	Var, Cer, 500KΩ	71450	5-73504
R96	RCR07G155JR	CC, 1.5MΩ, 1/4W, 5%	01121	5-10155
R97	RN55D7870F	MF, 787Ω, 1/8W, 1%	91637	5-51183
R98	RN55D3161F	MF, 3.16KΩ, 1/8W, 1%	91637	5-51241
R99	RN55D3161F	MF, 3.16KΩ, 1/8W, 1%	91637	5-51241
R100	RCR07G124JR	CC, 120KΩ, 1/4W, 5%	01121	5-10124
R101	RN55D3161F	MF, 3.16KΩ, 1/8W, 1%	91637	5-51241
R102	RN55D1581F	MF, 1.58KΩ, 1/8W, 1%	91637	5-51212
R103	360T504B	Var, Cer, 500KΩ	71450	5-73504
R104	RCR07G155JR	CC, 1.5MΩ, 1/4W, 5%	01121	5-10155
R105	RCR07G124JR	CC, 120KΩ, 1/4W, 5%	01121	5-10124
R106	RN55D3401F	MF, 3.40KΩ, 1/8W, 1%	91637	5-51244
R107	RN55D1071F	MF, 1.07KΩ, 1/8W, 1%	91637	5-51196
R108	360T201B	Var, Cer, 200Ω	71450	5-73201
R109	RCR07G124JR	CC, 120KΩ, 1/4W, 5%	01121	5-10124
R110	RCR07G101JR	CC, 100Ω, 1/4W, 5%	01121	5-10101
R111	RCR07G104JR	CC, 100KΩ, 1/4W, 5%	01121	5-10104
R112	RCR07G106JR	CC, 10MΩ, 1/4W, 5%	01121	5-10106
R113	RCR07G101JR	CC, 100Ω, 1/4W, 5%	01121	5-10101
R114	RCR07G106JR	CC, 10MΩ, 1/4W, 5%	01121	5-10106
R115	RCR07G104JR	CC, 100KΩ, 1/4W, 5%	01121	5-10104
R116	RCR07G822JR	CC, 8.2KΩ, 1/4W, 5%	01121	5-10822
R117	RCR07G512JR	CC, 5.1KΩ, 1/4W, 5%	01121	5-10512
R118	RCR07G222JR	CC, 2.2KΩ, 1/4W, 5%	01121	5-10222
R119	RCR07G124JR	CC, 120KΩ, 1/4W, 5%	01121	5-10124
R120	RCR07G124JR	CC, 120KΩ, 1/4W, 5%	01121	5-10124
R121	RCR07G124JR	CC, 120KΩ, 1/4W, 5%	01121	5-10124
R122	RCR07G473JR	CC, 47KΩ, 1/4W, 5%	01121	5-10473
R123	RCR07G103JR	CC, 10KΩ, 1/4W, 5%	01121	5-10103
R124	RCR07G473JR	CC, 47KΩ, 1/4W, 5%	01121	5-10473

Table 6-12. Parts List (Dmm/Freq Counter Sub-Assembly 9755001) (Continued)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
R125	RCR07G103JR	CC, 10KΩ, 1/4W, 5%	01121	5-10103
R126	RCR07G473JR	CC, 47KΩ, 1/4W, 5%	01121	5-10473
R127	RCR07G103JR	CC, 10KΩ, 1/4W, 5%	01121	5-10103
R128	RCR07G473JR	CC, 47KΩ, 1/4W, 5%	01121	5-10473
R129	RCR07G473JR	CC, 47KΩ, 1/4W, 5%	01121	5-10473
R130	RCR07G472JR	CC, 4.7KΩ, 1/4W, 5%	01121	5-10472
R131	RCR07G103JR	CC, 10KΩ, 1/4W, 5%	01121	5-10103
R132	RCR07G822JR	CC, 8.2KΩ, 1/4W, 5%	01121	5-10822
R133	RCR07G512JR	CC, 5.1KΩ, 1/4W, 5%	01121	5-10512
R134	RCR07G222JR	CC, 2.2KΩ, 1/4W, 5%	01121	5-10222
R135	RN55D1003F	MF, 100KΩ, 1/8W, 1%	91637	5-51394
R136	RN55D7872F	MF, 78.7KΩ, 1/8W, 1%	91637	5-51384
R137	RN55D9092F	MF, 90.9KΩ, 1/8W, 1%	91637	5-51390
R138	RCR07G105JR	CC, 1MΩ, 1/4W, 5%	01121	5-10105
R139	RCR07G105JR	CC, 1MΩ, 1/4W, 5%	01121	5-10105
R140	360T203B	Var, Cer, 20KΩ	71450	5-73203
R141	RN55D7502F	MF, 75.0KΩ, 1/8W, 1%	91637	5-51382
R142	RCR07G203JR	CC, 20KΩ, 1/4W, 5%	01121	5-10203
R143	RCR07G472JR	CC, 4.7KΩ, 1/4W, 5%	01121	5-10472
R144	RCR07G332JR	CC, 3.3KΩ, 1/4W, 5%	01121	5-10332
R145	RCR07G332JR	CC, 3.3KΩ, 1/4W, 5%	01121	5-10332
R146	RCR07G332JR	CC, 3.3KΩ, 1/4W, 5%	01121	5-10332
R147	RCR07G332JR	CC, 3.3KΩ, 1/4W, 5%	01121	5-10332
R148	RCR07G301JR	CC, 300Ω, 1/4W, 5%	01121	5-10301
R149	RCR07G124JR	CC, 120KΩ, 1/4W, 5%	01121	5-10124
R150	RCR07G122JR	CC, 1.2KΩ, 1/4W, 5%	01121	5-10122
R151	RCR07G122JR	CC, 1.2KΩ, 1/4W, 5%	01121	5-10122
R152	RCR07G122JR	CC, 1.2KΩ, 1/4W, 5%	01121	5-10122
R153	RCR07G122JR	CC, 1.2KΩ, 1/4W, 5%	01121	5-10122
R154	RCR07G122JR	CC, 1.2KΩ, 1/4W, 5%	01121	5-10122
R155	RCR07G122JR	CC, 1.2KΩ, 1/4W, 5%	01121	5-10122
R156	RCR07G122JR	CC, 1.2KΩ, 1/4W, 5%	01121	5-10122
R157	RCR07G472JR	CC, 4.7KΩ, 1/4W, 5%	01121	5-10472
R158	RCR07G511JR	CC, 510Ω, 1/4W, 5%	01121	5-10511
R159	RCR07G510JR	CC, 51Ω, 1/4W, 5%	01121	5-10510
R160	RCR07G393JR	CC, 39KΩ, 1/4W, 5%	01121	5-10393
R161	RCR07G510JR	CC, 51Ω, 1/4W, 5%	01121	5-10510
R162	RCR07G122JR	CC, 1.2KΩ, 1/4W, 5%	01121	5-10122
R163	RCR07G104JR	CC, 100KΩ, 1/4W, 5%	01121	5-10104
R164	RCR07G103JR	CC, 10KΩ, 1/4W, 5%	01121	5-10103
R165	RCR07G100JR	CC, 10Ω, 1/4W, 5%	01121	5-10100
R166	RCR07G100JR	CC, 10Ω, 1/4W, 5%	01121	5-10100
R167	RCR20G1R0JR	CC, 1Ω, 1/2W, 5%	01121	5-20010

Table 6-12. Parts List (Dmm/Freq Counter Sub-Assembly 9755001) (Continued)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
R168	RCR07G103JR	CC, 10KΩ, 1/4W, 5%	01121	5-10103
R169	RCR07G473JR	CC, 47KΩ, 1/4W, 5%	01121	5-10473
R170	RCR07G106JR	CC, 10MΩ, 1/4W, 5%	01121	5-10106
S1	9752001	Switch, Counter Range	34160	2-10048
S2	9752010	Switch, Dmm Function	34160	2-10049
		TERMINALS		
TP1	MP170-2	Mini-Pin .6 Long	PMP	2-24015
TP2	MP170-2	Mini-Pin .6 Long	PMP	2-24015
TP3	MP170-2	Mini-Pin .6 Long	PMP	2-24015
P1	MP165-2	Mini-Pin .3 Long	PMP	2-24016
P2	MP165-2	Mini-Pin .3 Long	PMP	2-24016
P3	MP165-2	Mini-Pin .3 Long	PMP	2-24016
P4	MP165-2	Mini-Pin .3 Long	PMP	2-24016
	MP170-2	Mini-Pin .6 Long	PMP	2-24015
	MP170-2	Mini-Pin .6 Long	PMP	2-24015
		TRANSISTORS		
Q1	2N3904	NPN, Signal	04713	3-23904
Q2	2N3904	NPN, Signal	04713	3-23904
Q3	2N3906	PNP, Signal	04713	3-23906
Q4	2N3904	NPN, Signal	04713	3-23904
Q5	2N3904	NPN, Signal	04713	3-23904
Q6	2N3904	NPN, Signal	04713	3-23904
Q7	2N3904	NPN, Signal	04713	3-23904
Q8	2N3904	NPN, Signal	04713	3-23904
Q9	2N3904	NPN, Signal	04713	3-23904
Q10	2N3904	NPN, Signal	04713	3-23904
Q11	2N3904	NPN, Signal	04713	3-23904
Q12	2N3904	NPN, Signal	04713	3-23904
Q13	2N3904	NPN, Signal	04713	3-23904
Q14	2N3904	NPN, Signal	04713	3-23904
Q15	2N3904	NPN, Signal	04713	3-23904
Q16	2N3906	PNP, Signal	04713	3-23906
Q17	UC410	Fet,	Solitron	3-20410
Q18	F2701	Fet, N, Ch	Solitron	3-22701
Q19	F2701	Fet, N, Ch	Solitron	3-22701
Q20	F2701	Fet, N, Ch	Solitron	3-22701
Q21	F2701	Fet, N, Ch	Solitron	3-22701
Q22	F2701	Fet, N, Ch	Solitron	3-22701
Q23	F2701	Fet, N, Ch	Solitron	3-22701
Q24	F2701	Fet, N, Ch	Solitron	3-22701

Table 6-12. Parts List (Dmm/Freq Counter Sub-Assembly 9755001) (Continued)

REFERENCE DESIGNATOR	MANUFACTURER PART NUMBER	DESCRIPTION	MANU-FACTURER	VU-DATA PART NO.
Q25	2N3904	NPN, Signal	04713	3-23904
Q26	F2701	Fet, N, Ch	Solitron	3-22701
Q27	F2701	Fet, N, Ch	Solitron	3-22701
Q28	2N3904	NPN, Signal	04713	3-23904
Q29	2N3904	NPN, Signal	04713	3-23904
Q30	2N3906	PNP, Signal	04713	3-23906
Q31	2N3904	NPN, Signal	04713	3-23904
Q32	2N3906	PNP, Signal	04713	3-23906
Q33	2N3904	NPN, Signal	04713	3-23904
Q34	2N3906	PNP, Signal	04713	3-23906
Q35	2N3904	NPN, Signal	04713	3-23904
Q36	2N3906	PNP, Signal	04713	3-23906
Q37	2N3906	PNP, Signal	04713	3-23906
Q38	2N3904	NPN, Signal	04713	3-23904
Q39	2N3906	PNP, Signal	04713	3-23906
Q40	2N3904	NPN, Signal	04713	3-23904
Q41	2N3904	NPN, Signal	04713	3-23904
Q42	2N3904	NPN, Signal	04713	3-23904
Q43	2N3904	NPN, Signal	04713	3-23904
Q44	F2701	Fet, N, Ch	Solitron	3-22701
		MISCELLANEOUS		
	570-1510-01-0519	Standoff	Cambion	4-20199
	9752007	Shield, Input	34160	1-20089
4 Req.	CDH4000-16	Socket, I.C., 16 Pin	SAE	2-60009
2 Req.	516-AG7D	Socket, Right Angle, 16 Pin	Augat	2-60008
4 Req.	S0-440-8	Standoff, 4-40 Captive, ¼"L	46384	
P5	1-480340-0	Pin Housing	Amp	
P5 – 6 Req.	61174-1	Pin	Amp	
9 Req.	9152030	Button	34160	1-10716
	MS51957-12	Screw, Panhead, 4-40 X 3/16"		
	MS35333-70	Washer, #4 Int. Lk.		

SECTION VII

DRAWINGS

List of Drawings:

Figure 7-1 Master Board Schematic-Horizontal 9151001

Figure 7-1 Master Board Schematic-Vertical 9151001 (Continued)

Figure 7-1 Master Board Schematic-Power Supply 9151001 (Continued)

Figure 7-2 Wiring Diagram Master Board 9151015

Figure 7-3 DMM/Frequency Counter Schematic 9751001

Figure 7-3 DMM/Frequency Counter Schematic 9751001 (Continued)

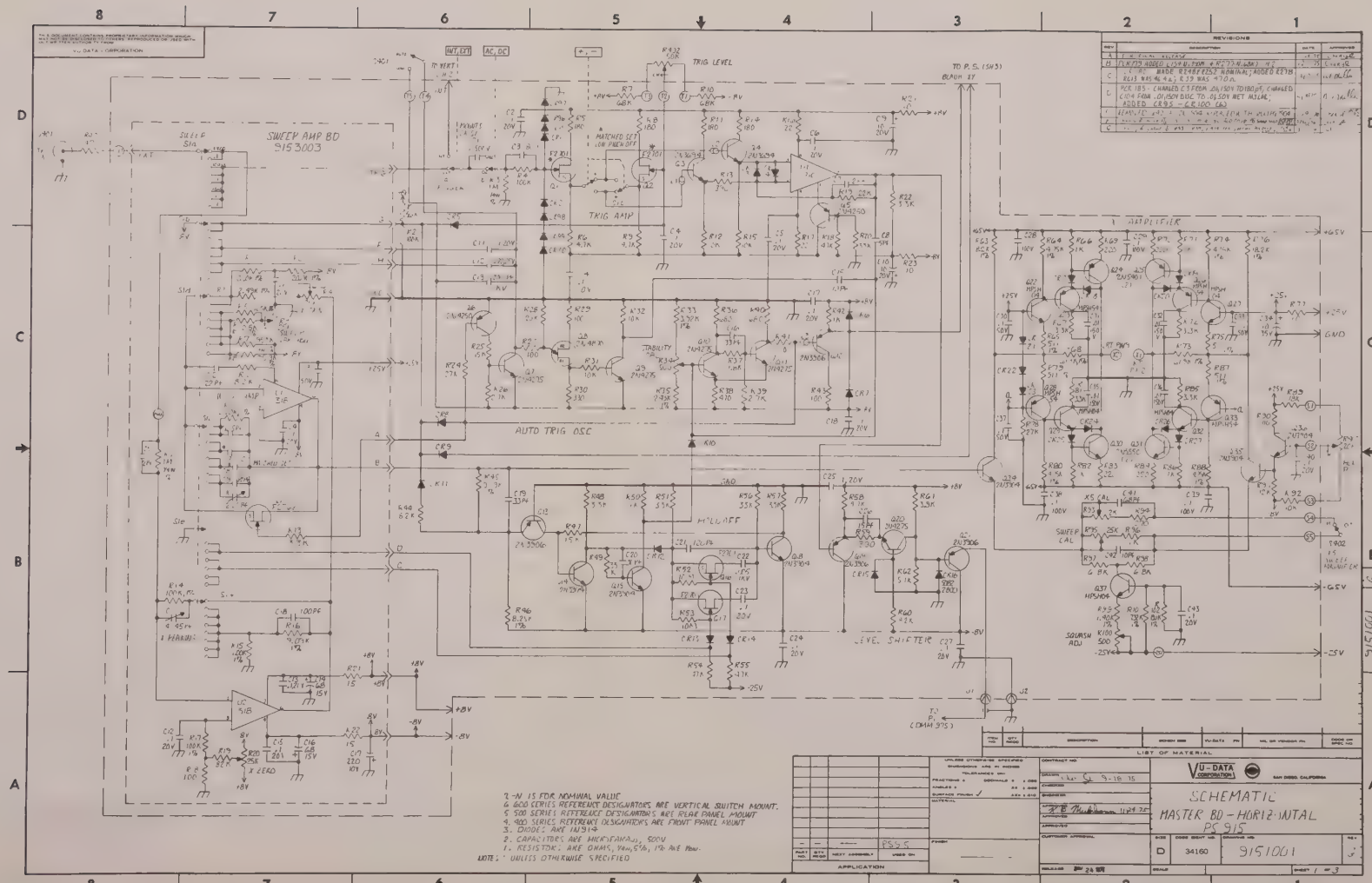


Figure 7-1 Master Board Schematic-Horizontal 9151001

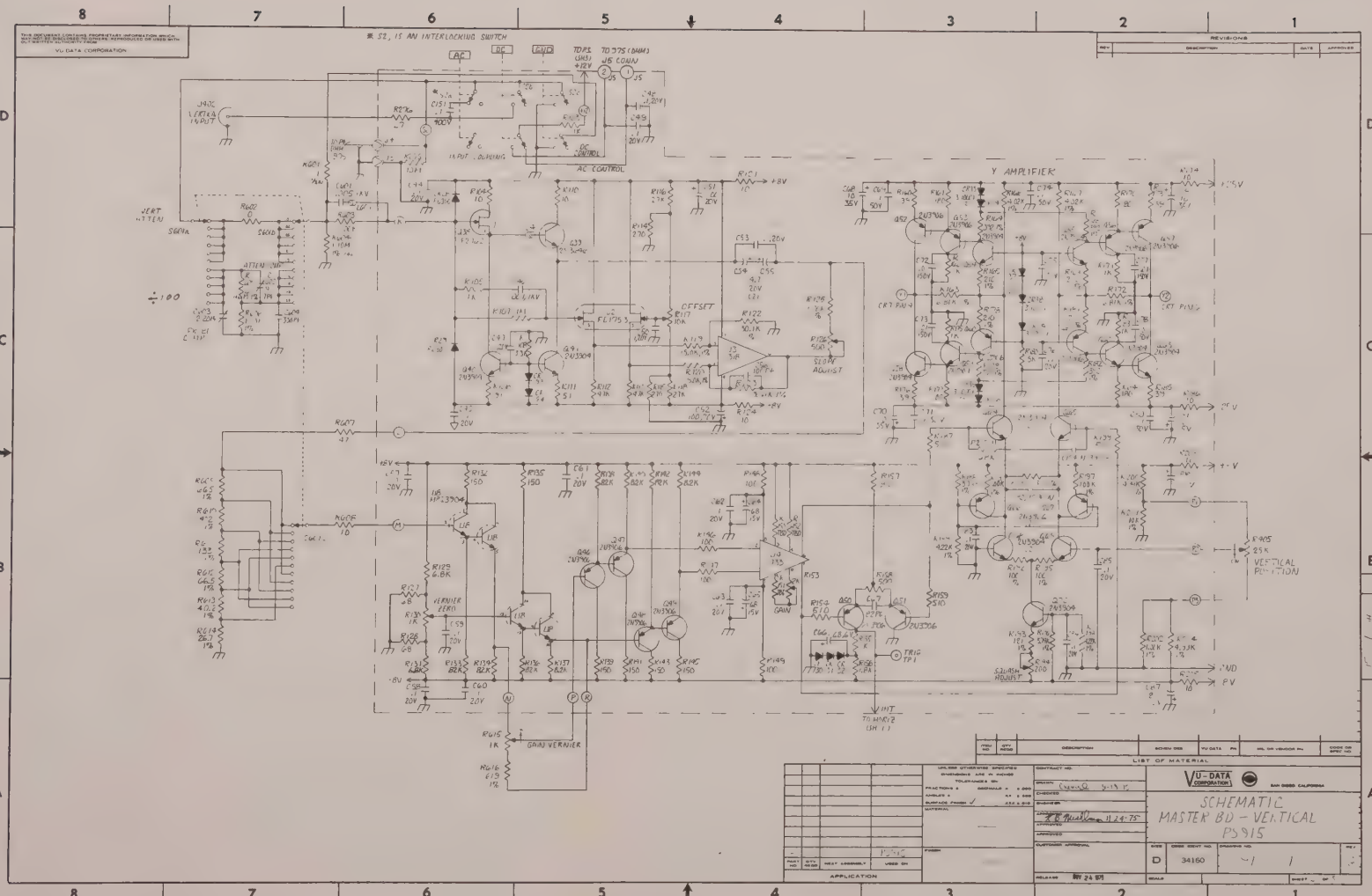


Figure 7-1 Master Board Schematic-Vertical 9151001 (Continued)

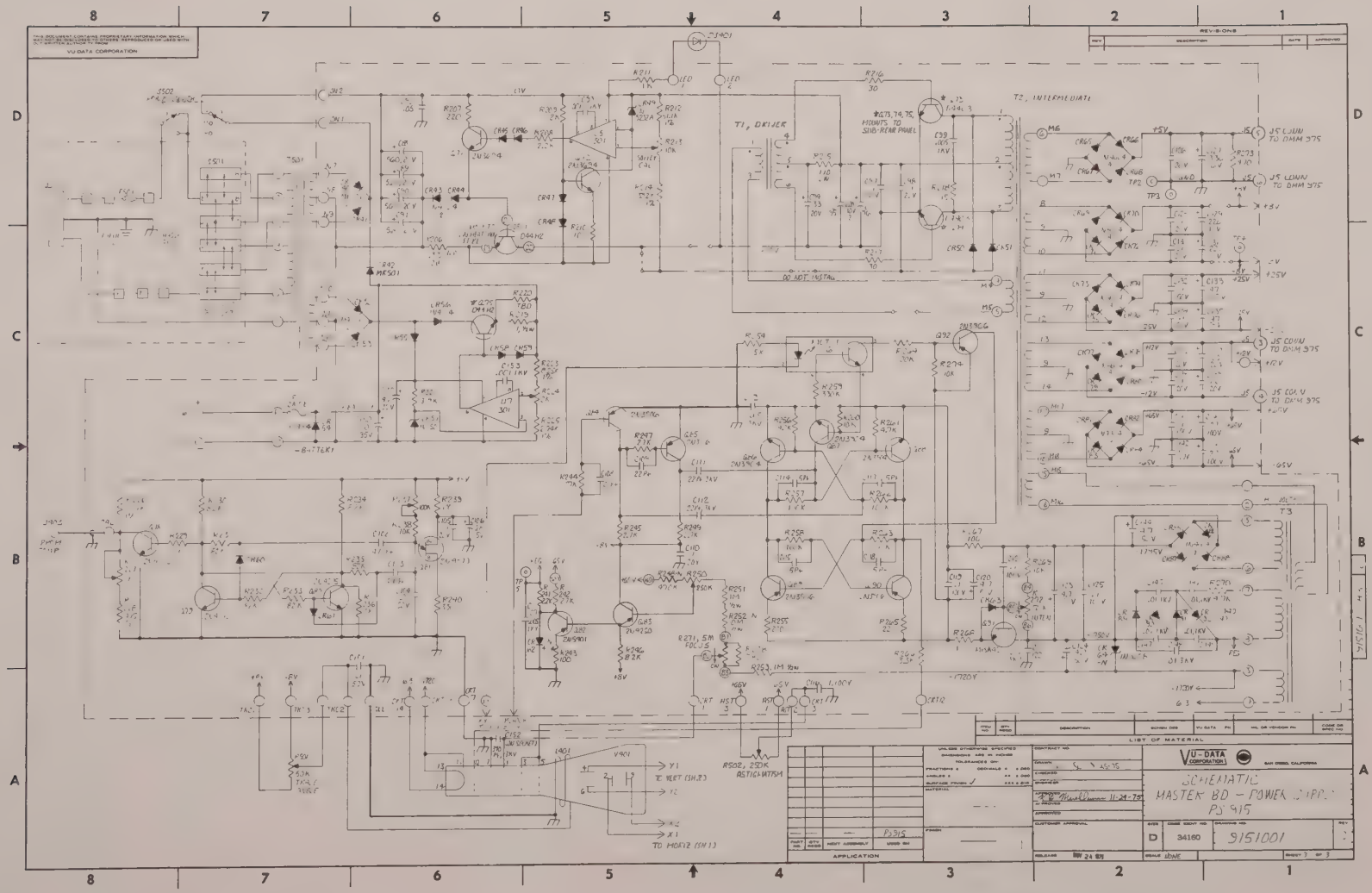


Figure 7-1 Master Board Schematic-Power Supply 9151001 (Continued)

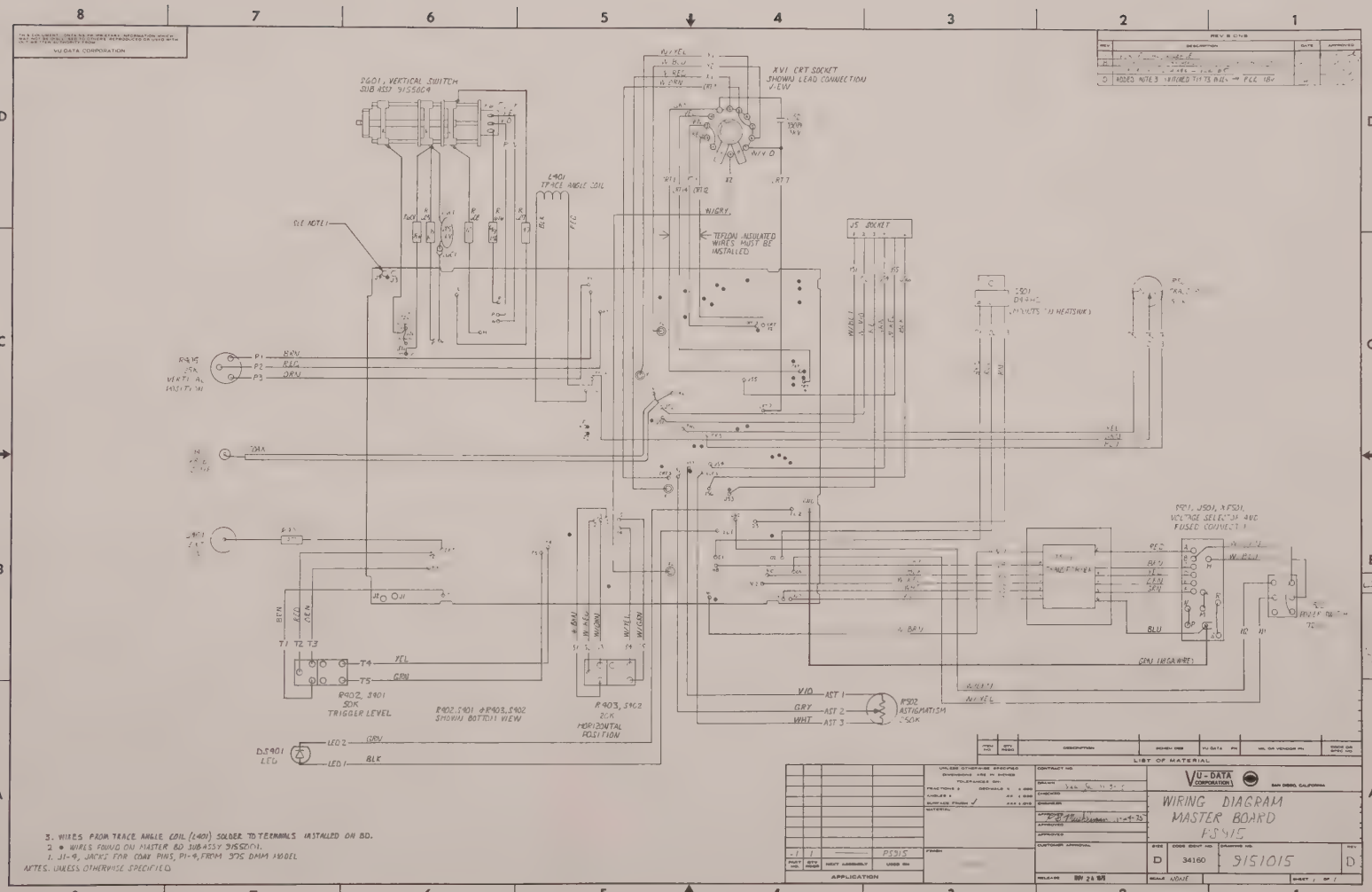

VU-DATA CORPORATION
XVI CRT SOCKET SHOWN LEAD CONNECTION VIEW
2901, VERTICAL SWITCH SUB ASSY 9155004
L401 TRACE ANGLE COIL
SEE NOTE 1
TEFLON INSULATED WIRES MUST BE INSTALLED
J5 SOCKET
2501 DIODE (MOUNTS ON HEATSINK)
RY1, J501, XF501, VOLTAGE SELECTION AND FUSED CONNECTOR
R902, 3901 50K TRIGGER LEVEL
R902, 3901 & R903, 3902 SHOWN BOTTOM VIEW
R 903, 3902 20K HORIZONTAL POSITION
R902 ASTIGMATISM 50K
D3901 LED
3. WIRES FROM TRACE ANGLE COIL (L401) SOLDER TO TERMINALS INSTALLED ON BD.
2. ● WIRES FOUND ON MASTER BD SUBASSY 9155004.
1. J1-9, JACKS FOR COAX PINS, P1-9, FROM 305 OHM MODEL
NOTES: UNLESS OTHERWISE SPECIFIED.
LIST OF MATERIAL
VU-DATA CORPORATION
WIRING DIAGRAM MASTER BOARD PS915
9151015
D
34160
APPLICATION

Figure 7-2 Wiring Diagram Master Board 9151015

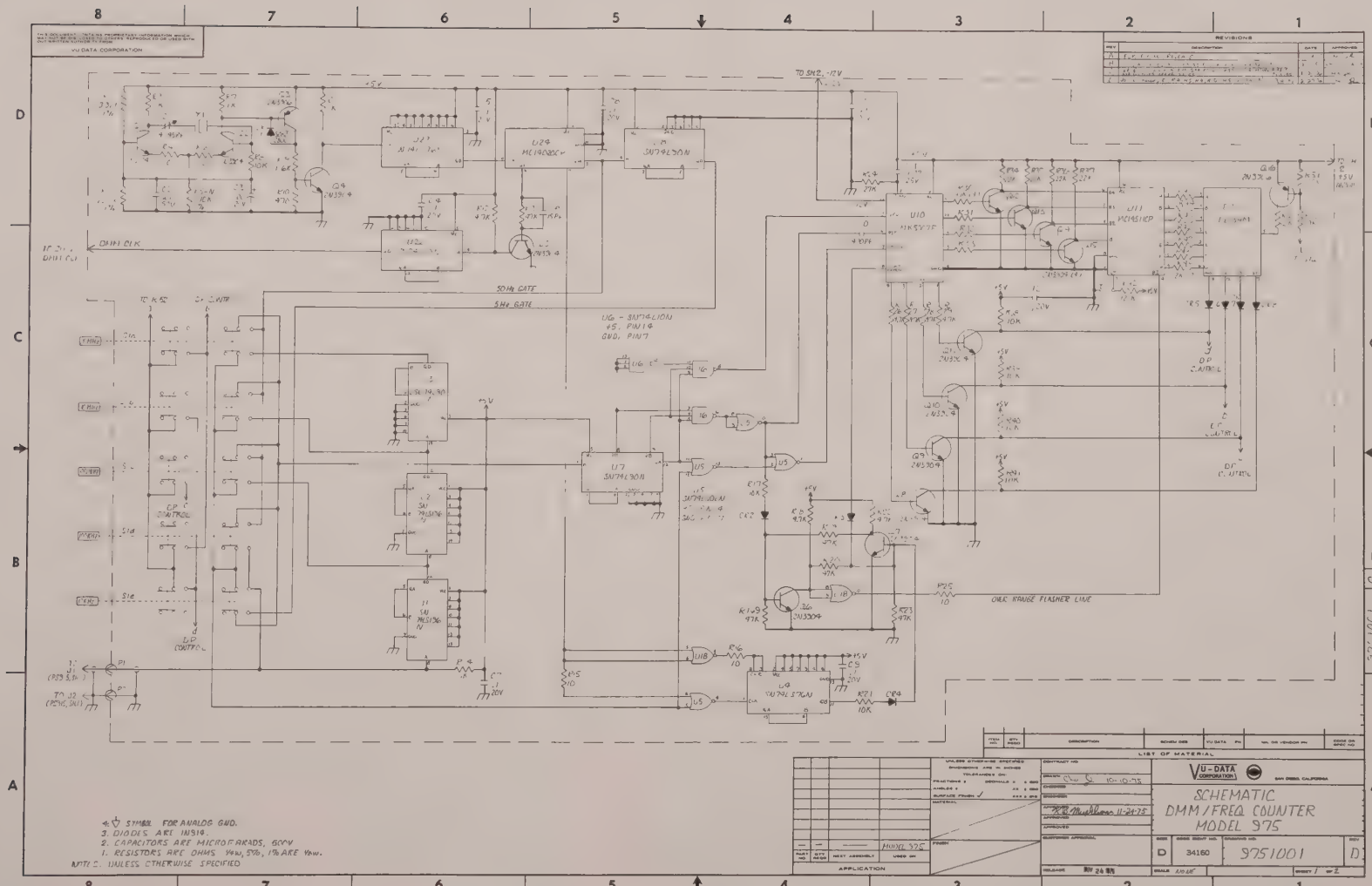


Figure 7-3 DMM/Frequency Counter Schematic 9751001

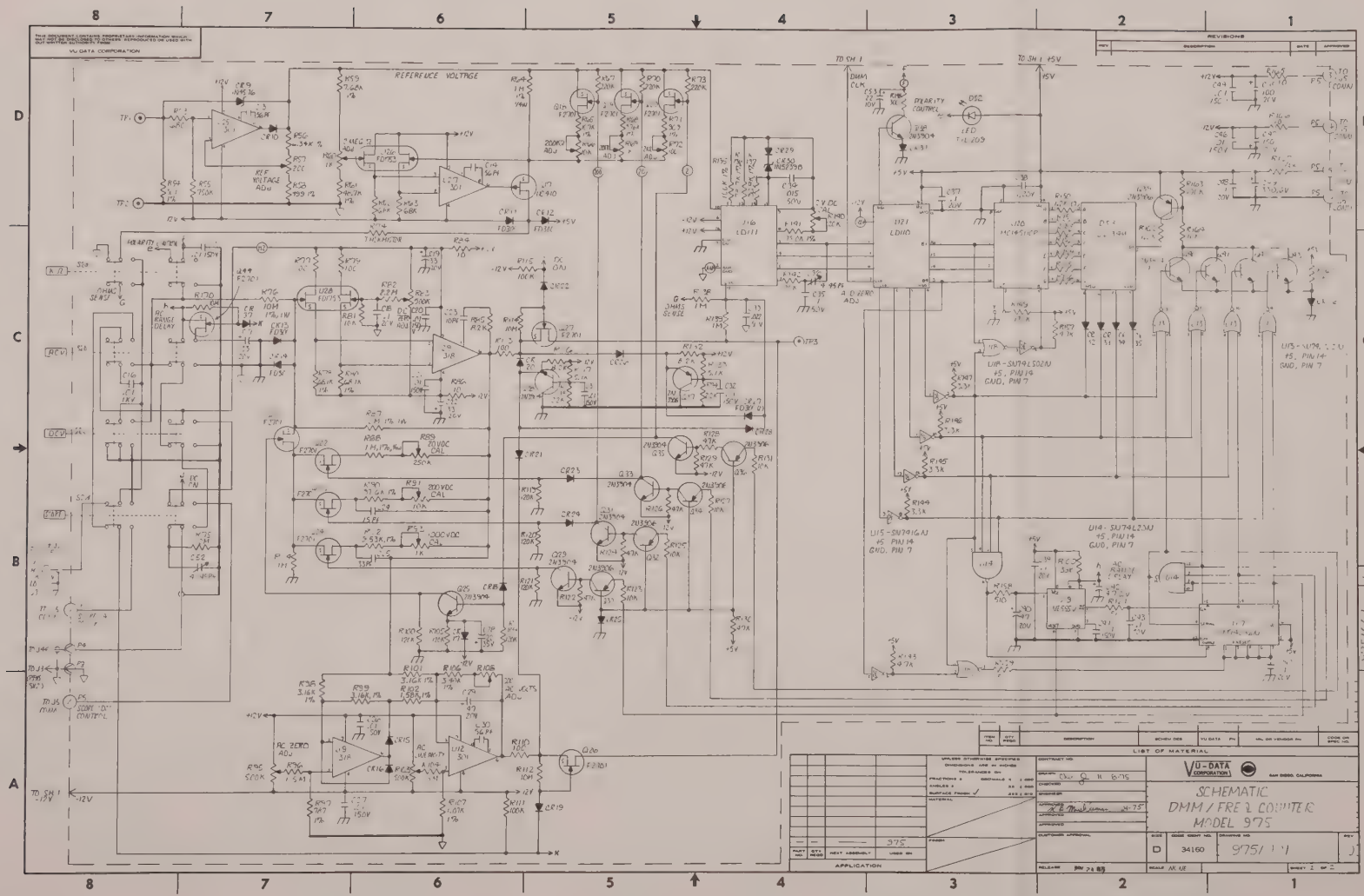


Figure 7-3 DMM/Frequency Counter Schematic 9751001 (Continued)

SECTION VIII

RECOMMENDED SPARES

The following is a list of recommended spare parts required to maintain a specific number of instruments at a satisfactory level of performance of one year in an isolated area.

ASSEMBLY OR PART NAME		PART NUMBER	QUANTITY OF PARTS		
			1 Inst.	5 Inst.	10 Inst.
915					
CRT Tube	D9-110GH	3-40006	1	2	3
Integrated Circuit	µA710	3-30710	1	2	3
Integrated Circuit	FD1753	3-21753	1	2	3
Integrated Circuit	LM318	3-30318	2	3	5
Integrated Circuit	µA733	3-30733	1	2	3
Integrated Circuit	LM301	3-30301	2	3	5
Integrated Circuit	MCT2E	3-10102	1	2	3
Integrated Circuit	MPQ3904	3-33904	1	2	3
Transistor	F2701	2-22701	2	4	6
Transistor	2N3694	2-23694	2	4	6
Transistor	2N4250	2-24250	2	4	6
Transistor	2N4275	2-24275	3	6	10
Transistor	2N4870	3-24870	1	2	3
Transistor	2N3906	3-23906	4	8	15
Transistor	2N3904	3-23904	4	8	15
Transistor	MPSH04	3-20004	2	4	6
Transistor	MPSH54	3-20054	2	4	6
Transistor	2N5401	3-25401	1	2	3
Transistor	2N5550	3-25550	1	2	3
Transistor	F2762	3-22762	1	2	3
Transistor	2N3646	3-23646	1	2	3
Transistor	D44C3	3-244C3	1	2	3
Transistor	D44H2	3-24442	1	2	3

The following is a list of recommended spare parts required to maintain a specific number of instruments at a satisfactory level of performance of one year in an isolated area.

			QUANTITY OF PARTS		
ASSEMBLY OR PART NAME		PART NUMBER	1 Inst.	5 Inst.	10 Inst.
975					
Integrated Circuit	74LS196	3-37196	1	2	3
Integrated Circuit	74L90	3-34490	2	4	6
Integrated Circuit	74LS76	3-34476	1	2	3
Integrated Circuit	74LS02	3-37402	1	2	3
Integrated Circuit	74L10	3-37410	1	2	3
Integrated Circuit	LM318	3-30318	2	4	6
Integrated Circuit	MK5007P	3-35007	1	2	3
Integrated Circuit	MC4511CP	3-34511	1	2	3
Integrated Circuit	LM301	3-30301	2	4	6
Integrated Circuit	74L20	3-34420	1	2	3
Integrated Circuit	7416	3-37416	1	2	3
Integrated Circuit	LD110	3-30110	1	2	3
Integrated Circuit	LD111	3-30111	1	2	3
Integrated Circuit	74L96	3-34496	1	2	3
Integrated Circuit	NE555V	3-30555	1	2	3
Integrated Circuit	MC14020CP	3-34020	1	2	3
Integrated Circuit	FD1753	3-21753	1	2	3
Transistor	2N3904	3-23904	4	8	15
Transistor	2N3906	3-23906	2	4	6
Transistor	UC410	3-20410	1	2	3
Transistor	F2701	3-22701	3	6	10
LED DISPLAY	DL-34M	3-10234	1	2	3

MODEL NUMBER _____ SERIAL NUMBER _____

WARRANTY

VU-DATA CORPORATION hereby warrants to each original purchaser of all instruments of Vu-data Corporation manufacture as follows:

I. At the time of delivery of all instruments to the original purchaser thereof, Vu-data Corporation UNCONDITIONALLY WARRANTS that all of such instruments shall be free from defects in parts, materials, and workmanship; and

II. Commencing with the date of delivery of all instruments to the original purchaser thereof, which delivery date for purposes of this warranty shall be deemed to be Vu-data Corporation's original shipment date, AND FOR A PERIOD EXPIRING ONE (1) YEAR FROM SAID DATE, Vu-data Corporation UNCONDITIONALLY WARRANTS that all such instruments shall remain free from defects in parts, materials, and workmanship.

In the event any instrument shall fail to meet the terms of this warranty, Vu-data Corporation agrees that if the original purchaser of any such instrument shall:

(1) Give to Vu-data Corporation's customer service department prompt notice in writing of the nature of any suspected defect; and

(2) Upon receipt of written authorization and shipping instructions from Vu-data Corporation, return the instrument with suspected defects, transportation charges prepaid, to Vu-data Corporation's main plant located in San Diego, California; then Vu-data Corporation shall replace any and all defective parts/materials and shall repair any and all defective workmanship and shall return the instrument, TRANSPORTATION CHARGES COLLECT, in good working order and state of repair to the original purchaser thereof, or in the alternative, Vu-data Corporation shall have the option to replace any such defective instrument by substituting a new instrument of the same type therefor, ALL WITHOUT ANY CHARGE WHATSOEVER:

The warranties herein contained shall not obligate Vu-data Corporation in any manner whatsoever with respect to, and shall not be applicable to, any defects which after an inspection of the instrument by Vu-data Corporation are not to Vu-data Corporation's reasonable satisfaction demonstrably the result of defective parts, materials or workmanship.

Vu-data Corporation reserves the right to modify or change the design or appearance of any of its instruments as it deems desirable. Nothing herein contained shall preclude such right or create any obligation to effect such changes on units previously purchased.

The remedies herein specified in the event of a breach of any of the warranties herein contained shall be the sole and exlusive remedies for such breach.

The warranties herein contained are intended to be and shall be construed as being in addition to and cumulative to all implied warranties contained in the Uniform Commercial Code, provided, however, that in the event of any breach by Vu-data Corporation of any of the implied warranties contained in the Uniform Commercial Code neither the purchaser of any Vu-data Corporation product, nor any other person, shall be entitled to recover by reason of such breach any incidental damages or consequential damages as those terms are defined in subsection 2–715 of the Uniform Commercial Code.

All warranties herein contained shall run only in favor of the original purchaser of Vu-data Corporation's instruments and all such warranties shall immediately terminate and become null and void and of no further force or effect whatsoever upon the sale or other transfer of any such instrument by the original purchaser. The warranties herein contained constitute the sole and exclusive warranties made by Vu-data Corporation of its instruments and no other express warranties not herein contained are given and no affirmation of fact, promise or representation made by any agent, employee or representative of Vu-data Corporation shall constitute a warranty. No agent, employee or representative of Vu-data Corporation has any authority to bind Vu-data Corporation in any affirmation of fact, promise, representation or warranty not herein expressly contained.

The above statements and warranty constitutes a part of Vu-data Corporation's standard Terms and Conditions of Sale as published in our Order Acknowledgement which together is Vu-data Corporation's warranty in its entirety.